WITH GOLD, AND OPENS BUT TO GOLDEN KEYS

HARMSWORTH SELF-EDUCATOR

A GOLDEN KEY
TO SUCCESS IN LIFE

HARMSWORTH SELF-EDUCATOR

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A KEY TO THE HARMSWORTH SELF-EDUCATOR

At the heading of each article in the SELF-EDUCATOR is the number of the group to which the article belongs, and a reference to this key indicates precisely the place of the article in the scheme of the book. This key, therefore, enables the student at any time to understand what has preceded and what is to follow any part of the work to which he may happen to turn.

GROUP 1.

Agriculture. Beekeeping. Gardening.

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BEEKEEPING. A Practical and Commercial Course.
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GROUP 6.

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ARMY AND NAVY. How to Enter Them.

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INSURANCE. Life, Fire, Accident, Marine.
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ESTATE AGENCY. Departments and Officials of a Great Estate. Training a Land Agent.
MEDICINE. Training of a Doctor. Specialists. Veterinary Surgeons. Chemists and Druggists. Dentistry: The Dental Mechanic. Home and Professional Nursing.
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GROUP 12.

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MILITARY ENGINEERING. Pontoons. Bridges. Fortifications. Rafts. Trenches. Passing Rivers. Conditions in Peace and War.
ARMS AND AMMUNITION. Manufacture of Arms and Explosives.

GROUP 13.

Geography. Astronomy.

GEOGRAPHY. Physical. Political. Human. Commercial.
ASTRONOMY. A Survey of the Solar System.

GROUP 14.

Geology. Mining. Metals and Minerals. Gas.

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MINING. The Practice of Mining: Coal, Gold, Diamonds, Tin, etc.
METALS. Metallurgy. Iron and Steel. Iron and Steel Manufactures. Metal Work. Cutlery.
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GROUP 15.

History.

HISTORY. A Short History of the World.

GROUP 16.

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PATENTS AND INVENTIONS. How to Protect an Idea.
APPLIED EDUCATION. Application of Education in Every Walk of Life.

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GROUP 19.

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LITERATURE. A Survey of the World's Great Books and their Writers. Poetry. Classics. Fiction. Miscellaneous. How to Read and Write.
JOURNALISM. A Guide to Newspaper Work, with Practical Training.
PRINTING. Composing by Hand and Machine. Type Cutting and Founding. Engraving and Blocks. Bookbinding and Publishing
LIBRARIES. Officials and Management of Libraries.

GROUP 20

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MATERIALS. The Characteristics and Strength of Materials.
STRUCTURES. The Stability of Structures.
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SINGING. The Voice and Its Treatment.
AMUSEMENT. Drama and Stage. Business side of Amusement. Sports Officials.

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Natural History. Applied Botany. Bacteriology. Natural Products.

NATURAL HISTORY. Kingdom of Nature. Its Marvels, Mechanism, and Romance. Animal Life. Flowers. Plants. Seeds, Trees, Ferns, Mosses, etc.
APPLIED BOTANY. Tobacco & Tobacco Pipes. Forestry. Rubber and Gutta Percha. Basket and Brush Making. Cane Work. Barks (Cork, Wattle).
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PHYSICS. A Complete Course in the Science of Matter and Motion.
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PRIME MOVERS. Engines. Steam. Gas. Heat. Turbines. Windmills.

GROUP 25.

Physiology. Health. Ill-health.

PHYSIOLOGY. Plan of the Body. Digestive, Circulatory. Respiratory, Locomotor and Nervous Systems. The Senses.
HEALTH. The Five Laws of Health. Personal Hygiene. Environment. State Medicine and the Public Health.
ILL-HEALTH. General Ill-health. Its Special Forms. Common Ailments and Domestic Remedies.

GROUP 26.

Shopkeeping. Business Management. Publicity.

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BUSINESS MANAGEMENT. The Application of System in Business.
PUBLICITY. Advertising from all Points of View As a Business.

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SHORTHAND. Taught by Pitmans. TYPEWRITING. Working and Management of all Machines.

GROUP 28.

Textiles and Dyeing.

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DYEING. Dyes and Their Application.

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Travel and Transit.

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TRANSIT. A General Survey of Means of Communication.
VEHICLES. The Construction of Air, Land and Sea Vehicles.
RAILWAYS. The Management and Control of Railways.
SHIPS. Shipbuilding. Shipping. Management of Ships.

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THE STATE LADDER OF LEARNING

II.* OPPORTUNITIES FOR BOYS IN THE BRITISH ISLES

By W. H. Stuart Garnett

"WHOSO has sixpence," said the Sage of Chelsea, "is monarch, to the extent of sixpence, over all men; he commands cooks to feed him, philosophers to teach him, kings to mount guard over him—to the extent of sixpence." But we have changed a good many things since Carlyle's day, and the student of the present commands philosophers to teach him even if the sixpence be wanting. Under the Customs and Excise Act of 1890, and the Education Acts of 1902 and 1903, the various local authorities have certain sums to administer, a part of which they are bound to devote to the purposes of higher education; and, as a matter of fact, most of the county and borough councils devote a large part of these sums to the provision of scholarships for the support of students of moderate means at the secondary schools and technical and university colleges throughout the kingdom.

Scotland's Ladder. The sums awarded by the local authorities in Scotland for the direct encouragement of education in this sense compare very unfavourably with those granted in the sister kingdom. Lanark—the county which has been most liberal in the allocation of bursaries to technical education—expended, in 1904, £1,572 in bursaries for the promotion of technical education, and £187 in bursaries for the promotion of secondary education; Kincardine also granted the large sum of £1,207 in bursaries, but this, on the other hand, was devoted entirely to the promotion of secondary education. For the most part, however, the sums granted in scholarships by the Scottish authorities are small, amounting for the whole of Scotland to £7,309 17s. granted to secondary, and £4,319 7s. 8d. granted to technical students.

On the other hand, Scotland has done better than England in the provision of schools and colleges. Since 1872 Scotland has had the advantage of a system of educational administration substantially the same as that introduced in England by the Education Acts of 1902–3, under which primary and secondary education are co-ordinated and controlled by a single authority. The result is that in all the larger towns excellent secondary schools are provided by the school boards, to which elementary school children are admitted by examination up to the age of 12 years, and in which a free education is given until the pupils are of age to enter the universities.

There is little, if any, social distinction between the secondary schools (whether they have free places or not) provided by the school boards and those which are not under the same control; and the most historic school in the country, the Royal High School, Edinburgh, the school of Walter Scott, which derives its title from a patent of James VI., is now managed by the Edinburgh School Board.

Ireland's Educational Institutions. In Ireland scholarships are divided into three classes, open to candidates below the ages of 16, 17, and 18 respectively, and are awarded to those students who attain a satisfactory standard at the examinations of the Irish Intermediate Board. In 1905, 225 scholarships were so awarded, the boys taking 159 and the girls 66. At first sight both the number and value of these scholarships compare rather unfavourably with the corresponding figures for the English counties, but the lower cost of all kinds of education in Ireland, and the extensive provision of free schools by the different religious societies, entirely prevent any grievance in this connection.

Unquestionably the real hardship under which the Irish student labours is the difficulty of obtaining a university education, if, like the majority of his countrymen, he hold the Catholic faith. The four university colleges of Ireland set out in one of the subjoined tables are all of a distinctly Protestant type, so that Catholic parents are, not unreasonably, unwilling to send their sons to institutions which they hold to be subversive of faith. Maynooth, on the other hand, is distinctly a clerical seminary, and does not lay itself out to provide the Catholic laity with a university education on broad lines.

There are certain Catholic colleges in the country, of which University College, Dublin, is the best and largest; but, on the whole, these are not equal to the larger and wealthier Protestant institutions, and the provision of means of education for the Irish Catholic must be regarded as sadly inadequate.

Wales. The provision of scholarships in Wales is in many districts unsatisfactory. The county of Glamorgan gives a large number, and Carnarvon is nearly as liberal; in the other counties, however, very few scholarships are given, and these are chiefly agricultural.

The first and second of this series of tables are an attempt to represent in a small compass the facilities for secondary education afforded to a boy resident in any part of the British Isles. The other tables show in the same way the means of university and technical education.

As far as primary education is concerned, the uniformity which prevails over the country makes it unnecessary to provide such a table. We shall only remark that in England and Wales primary education is provided by the local education authorities constituted by the Education Acts of 1902 and 1903; in Scotland the provision is made by the school boards under the Act of 1872; while in Ireland there are no public elementary schools, but the greater part of the burden of elementary education is borne by voluntary schools deriving the greater part of their maintenance directly from the State, but subject to parochial control.

There are also a large number of elementary and other schools in Ireland, some of them of a

* A previous article on this subject appears on page 481.

THE LEADING FIRST GRADE SECONDARY SCHOOLS OF ENGLAND

COUNTY.	GRANT.	FIRST GRADE SECONDARY SCHOOLS.	FEES.		SCHOLARSHIPS.	
			DAY BOYS.	BOARDERS.	ENTRANCE.	LEAVING.
Bedfordshire ..	None	Bedford Grammar School	10—16gs.	£76 13	20 of £10—£60	2 of £60—£70
		Bedford Modern ..	£4—£6	£50—£60	4 of fees	1 of £55, 1 of £45
Berkshire ..	£1,122	Bradfield College ..	£25	80—90gs.	Numerous	One
		Reading School ..	£21—£31	£75—£85	18 of £20—£40	3 £100 in alternate years
		Windsor: St. Mark's	£20—£25	£60—£73	8 of £10—£70	None
		Wellington College..	None	£95—£110	10 of £30—£80	5 occasional £30—£50
		Abingdon College ..	£10 10	£55	2 of £20	1 of £75
		Radley College ..	None	£97 13	10 of £20—£80	1 of £50
Buckinghamshire	£573	Eton College.. ..	None	£162	12 about £140	9 or more £46—£80
Cambridgeshire	£757	Leys School	None	£103—£109	Indefinite no. of £40—£75	None
		Perse School.. ..	10gs.—£16	None	Numerous	None
Cheshire ..	£4,346	Chester: King's School	12—15gs.	40—46gs.	4 free	3 of £60, 1 of £30
Cumberland ..	£778	Carlisle Grammar School	£6—£10	£52	2 or 3 free	5 or 6 restricted
		St. Bee's	£8—£12	£33—£55	Numerous	2 or 3 of £40
Derbyshire ..	£3,030	Buxton College ..	£12	£48—£60	9 free	None
		Trent	None	£75	8 of £30—£50	None
Devonshire ..	£1,238	Tiverton: Blundell's	16gs., or £23 6 6	£75—£80	10 of £20—£50	5 of £60 and others
		Plymouth College ..	£22	£63	Several	3 of £20
		Tavistock	£15	£66	Several £15—£58	Occasional £50
		Exeter	£10—£18	£48—£68	4 of £20—£48	Numerous
Dorsetshire ..	£1,457	Sherborne	£30	£88 7	£21—£50	2 annually
Durham ..	£3,281	Durham	£16 16	£73 10	5 of £20—£50	Numerous
Essex	£3,495	Felsted	£20	£80—£88	8 of £20—£70	2 of £50—£60
		Chigwell	£18 18	£72	Ten	2 or more
Gloucestershire	£4,753	Clifton	£24 to £46 10	About £105	10 or more £25—£100	1 or more £25—£50
		Cheltenham Coll. ..	£23—£34	£100	15—20 of £20—£80	Several of £25—£80
		Cheltenham: Dean Close School	£15—£18	£51	5 of £25—£50	1 of £20
Hampshire ..	£1,884	Winchester College..	None	£117	Numerous £40—£90	6 of various values
		Portsmouth Grammar School	£10—£12	None	1 of £4—£6	Uncertain £40—£64
Herefordshire..	£449	Hereford School ..	12—14gs.	£55—£65	8 or more free	Numerous £25—£60
Hertfordshire..	£1,718	Haileybury	None	£81	16 of £50 and under	5 of £20—£60
		Berkhamsted ..	£6—£9	£59	2 of £8—£12	1 of £60
		Aldenham	None	£68	Numerous	About 8 of £50
Kent	£2,917	Tonbridge	£16—£30	£76—£96	About 10 of £16—£40	5 of £30—£80
		Rochester: King's School	£15	£60	3—5 of £15—£20	1 of £45, 1 of £60
		Sutton Valence ..	£9	£60—£70	Several of £18—£40	2 of £30—£60
		Canterbury: King's School	£22 10	£70—£85	25—30 of £10—£40	2 of £50
		Dover College ..	£22	£84	6 of £25—£60	1 of £50
		Ramsgate: South-Eastern College	24gs., limited and conditional	£60—£75	5 or more of £15—£40	1 of £50

THE LEADING FIRST GRADE SECONDARY SCHOOLS OF ENGLAND—continued

County.	Grant.	First Grade Secondary Schools.	Fees.		Scholarships.	
			Day Boys.	Boarders.	Entrance.	Leaving.
Lancashire ..	£12,652	Rossall	None	70gs.	8—10 of £10—£63	1 or more
		Manchester Grammar School	12—15gs.	None	Numerous	Numerous
		Liverpool College ..	£16—£25	£80	None	Several of £22—£50
		Lancaster School ..	8—12gs.	£63	2 of £30	7 of £30—£50
		Crosby: Merchant Taylors' School	£12—£15	£52—£60	5 or 6 free	1 of £40
		Stonyhurst	None	50—65gs.	None	4 of £30—£60
Leicestershire	£1,408	Leicester: Wyggeston School	£5—£9	None	About 30	Several of £30—£100
Lincolnshire ..	£2,380	Grantham School ..	£24	£55—£65	Several of £8—£15	2 or more of £25—£40
		Boston School ..	£6	None	Several free	2 Exhibitions £20—£50
Middlesex ..	£2,037	Mill Hill	21—24gs.	75—84gs.	6 of £15—£50	1 of £70 and others
		Harrow	£53 9	£143 9	4 of £35—£100	Numerous £20—£100
Norfolk ..	£4,560	Holt: Gresham School	£9	£67	8 of £39—£54	1 or more of £60
		Norwich School ..	£16 10	£61 10 to £70 10	None	1 of £30
Northamptonshire	£2,023	Oundle	£21	£81	Numerous	4 of £50
Northumberland	£2,322	Newcastle Grammar School	£8—£12	None	None	Several
Nottinghamshire	£2,006	Nottingham High School	£12 12	None	Numerous	3 of £50—£60
Oxfordshire ..	£766	Oxford High School	£12 12	None	Several	Three
		Oxford: St. Edward's	£33	£70—£85	Several of £40—£60	None
Rutlandshire ..	Nil	Oakham School ..	£8—£17 10	£53—£70	3 of £20—£40	4 of £50
		Uppingham	£42	£115	6 of £30—£70	3 or more of £40—£60
Shropshire ..	£2,633	Shrewsbury School..	£27	£90	6 of £30—£87	Numerous
Somersetshire	£2,464	Bath College	£20—£30	£91	10 of £15—£90	None
		Bath: Monkton Combe	16—27½gs.	£70 7—£81	4 of £30—£50	1 of £100
Staffordshire ..	£3,400	Wolverhampton ..	£6—£13 10	£40—£50	Under revision	5 of £25—£60
		Newcastle: High School	£13 10	£63 10	Several	1 or more
		Denstone College ..	None	£46	5 of £14 14	Uncertain
Suffolk ..	£1,405	Woodbridge	£6—£8	£45—£50	Several of £20—£32	1 or more of £50
		Ipswich	£12—£15	£63	12 of £15	4 of £36—£50
Surrey	£3,628	Godalming: Charterhouse	£31 10	£115 10	10 of £76 10	5 of £80
		Epsom College ..	£25	£68—£78	Several of £30	Variable
Sussex	£1,921	West Horsham: Christ's Hospital	None	Partly free	Several	Occasional £25
		Lancing College ..	None	£73 10 to £100	7 open exhibitions	None
		Eastbourne College..	£27	£87	6 of £30—£60	1 of £50
		Brighton College ..	£21—£30	£72—£93	3 of £50—£70	5 of £30—£60

THE LEADING FIRST GRADE SECONDARY SCHOOLS OF ENGLAND—concluded

County.	Grant.	First Grade Secondary Schools.	Fees. Day Boys.	Fees. Boarders.	Scholarships. Entrance.	Scholarships. Leaving.
Warwickshire	£896	Rugby	£46	£120	10 or more of £20—£100	7 of £30—£60
		Birmingham: (King Edward's)	£15	None	Large number	3 of £50, 1 of £30, 1 of £15
		Warwick School ..	£15	£63	12 of £20—£40	4 of £50
Wiltshire ..	£1,448	Marlborough	£30 or £35	£80—£85	70 or more of £30—£80	4 of £20—£50
Worcestershire	£997	Malvern College ..	£30	£98 9	13 of £30	1 of £40
		Worcester College ..	12—15gs.	£50—£60	4 of £15—£50	2 or more of £40
		Bromsgrove School ..	£16 16	£84	4 of £20—£60	1 of £60
Yorkshire West Riding	£13,845	Sedbergh	£22 10	£68 10 to £77 10	None	1 of £66 13
		Giggleswick	£14 2	£66—£78	Several	Preference Exhibitions
		Bradford Grammar School	£10—£16	None	40 free	5 Variable
		Leeds Grammar School	£10 10	None	10 of £10—£20	6 of £50
		Wakefield Grammar School	6—12gs.	£39—£42	Numerous	9 of £40—£50
Yorkshire North Riding	£2,210	York: St. Peter's School	12—15gs.	£65	2 or more of £15—£35	1 of £50
		York: Bootham School	None	£60	4 or more	Occasional Prize of £200
Yorkshire East Riding	£1,512	Hull: Hymer's College	£7 10—£15	£58—64	4 or more free	1 annually
		Pocklington School ..	£15	£55—£65	Few; many internal	5 of £40
Isle of Man ..	None	King William's College	None	£47 5 to £52 10	2 of £50 and others	2 of £30—£40
London ..	£41,750	City of London School	£15 15	None	18 of £15—£20	Numerous
		Dulwich College ..	£24	None	4—6 free	4 of £75
		Highgate School ..	£24	£84	3 or more	2 of £40—£60
		King's College School, Wimbledon	21—30gs.	None	Several of £20—£80	None
		Merchant Taylors' School	12—15gs.	None	Variable	Numerous
		Southwark: St. Olave's	£4—£10	None	Several	1 or more of £30—£80
		St. Paul's School, West Kensington	£24 9	£84 9	About 30 free	8 of £40—£80
		Gower St.: University College School	18—24gs.	99gs.	9 of 12—24gs.	3 of £10—£20
		Westminster School	30gs.	95gs.	10 or more of £20—£70	11 of £40—£80

very high order of merit, provided by various religious societies, of which the largest is the Society of Christian Brothers. The elementary schools of these societies, and many of their secondary schools, are entirely free, or else charge only a nominal fee; and, further, the ablest boys in the lower grade schools are frequently offered the opportunity of passing without cost through the higher and intermediate schools of the societies.

In the first table of First Grade Secondary Schools the first column shows the county or district under consideration. The second column shows the total sum awarded by the English and Welsh counties, and the boroughs within their geographical limits, in scholarships of any kind during the year 1903. Since that time many counties have raised their awards, but a complete statement on the subject is not yet obtainable.

In the third column of the first Secondary Schools table are shown the leading secondary schools situated in the different counties. The standard is not quite uniform; many schools have been omitted in the London district, and in some of the large provincial centres, that would have deserved mention had they been situated in Northumberland or Cornwall. A child is not, of course, confined to the schools of his, or her, own county. A boy living in Huntingdonshire, for instance, has numerous and excellent schools accessible in Bedford and Cambridge.

FIRST GRADE SECONDARY SCHOOLS OF SCOTLAND, IRELAND AND WALES

Total Grants: Scotland, £11,630. Ireland (Exhibits awarded in 1905), £6,160. Wales, £5,590

N.B. It must not be supposed that the descriptions "Protestant" and "Catholic" imply that the schools in question are closed to boys of other faiths. The Scholarships in Irish schools last generally for one year only.

	SCHOOL.	FEES.		SCHOLARSHIPS.	REMARKS.
		Day Boys.	Boarders.		
Scotland					
Edinburgh ..	Royal High School ..	£5—£8	£60—£100	13 of £20; 9 of £30	
	Merchiston Castle School	£30	£90—£100	2 of £20; 1 of £45	
	George Watson's College	£8 12 6	None	20 of £10—£21; 3 of £25	
	George Heriot School ..	Low	None	Numerous	
	Daniel Stewart's College	2½gs. to £8 12s. 6d.	None	20 of £10—£20; 1 of £100	
	Fettes School, near Edinburgh	£30	£105	Several of £30—£60	
	Edinburgh Academy ..	£24—£28	£94	3 free	Principally a day school
	Loretto	None	£105—£110	Musical only	
Aberdeen ..	Robert Gordon's College	£7	None	Numerous	Chiefly a science school
	Grammar School ..	5gs.—£8 5	None	Numerous	
Glasgow ..	Allan Glen School ..	Low	None	46	Well equipped for science
Dundee ..	High School	£10—£12	None	Numerous	
Perthshire ..	Glenalmond: Trinity College	None	90—100gs.	Several £20—£70	
Ireland					
Dublin.. ..	St. Andrew's College ..	£8—£16	£50—£60	10 free	Protestant
	Christian Schools, North Richmond Street	Free	None	Boys leaving are eligible for free places in Christian Brothers' intermediate schools	Catholic
	Castleknock College ..	None	£30	None	Catholic
	Mountjoy School ..	£7—£13	40—52gs.	3 of £15—£30; 4 of £25	
	Blackrock College ..	7—8gs.	36—40gs.	8 of £20	Catholic
Belfast.. ..	Campbell College ..	£7 10—£15	£35—£60	6 of £20—£60	Protestant
	Royal Academical Institute	6—12gs.	None	6 of £15—£30	
	Methodist College ..	8—12gs.	33—42gs.	6 of £10—£20	Protestant
Cork	Christian Brothers' College	8—10gs.	None	Free places for boys from Christian Brothers' schools	Catholic
	Christian Schools, North Monastery	Free	None	Boys leaving are eligible for free places in Christian Brothers' intermediate schools	Catholic
Londonderry ..	St. Columb's College ..	£6	None	14 free and 7 of £30	Catholic
	Foyle College	4—8gs.	£36 4 to £43 8	14 of fees; 2 of £30	Undenominational
Enniskillen ..	Portora Royal School ..	£8 10	£52 10	None	Undenominational
Fermoy ..	St. Colman's College ..	None	£30	16 of £10—£30	Catholic
Cashel	Rockwell College ..	None	£30	9 of £15	Catholic
Wales					
Brecon.. ..	Christ College	10gs.	50gs.	2 of £50 and others	
Caermarthen ..	Llandovery College ..	£9 6	£55	Numerous	

Fees and Allowances. The fourth column of the first Seconday Schools table shows the fees for day boys and boarders in the different schools. In many cases these increase with the age of the boys. Where the second fee is not given, no provision is made for boarders, and in a few cases no day pupils are admitted. These fees are the inclusive charges made by the schools themselves. It does not necessarily follow that a boarder can live at the school at a cost to his parents of the fee mentioned. It would be absurd to suppose that it is possible to send a boy to Eton at a

UNIVERSITIES AND UNIVERSITY COLLEGES OF THE UNITED KINGDOM

Universities and Colleges.	Fees.	Scholarships.	Remarks.
England			
Oxford	Minimum cost in college £140 — £160. Non-collegiate, £100	110—120 of £80 per ann. Numerous smaller ones	There are 21 colleges, 2 halls, and about 200 non-collegiate students
Cambridge	Minimum cost £140—£160 in coll. Non-collegiate, about £100	35 of £80, 52 of £60, and many smaller. 6 non-collegiate of £25—£30	There are 17 colleges, 1 hostel, and about 100 non-collegiate students
London University—*viz.*:			
University College	£21—£40	4 of £30—£40	Evening classes, fees about £1 5
King's College	£25—£50	11 of £15—£50	
Central Technical College	£30	6 of £30—£60	Electrical dept. very strong
Goldsmith's College	£16	A day training college	A few cheap evening classes
Royal College of Science and School of Mines	£30—£40	Very numerous	Metallurgy strong
London School of Economics	Depend on course	Variable. £25—£100	A higher commercial college
Durham University	£18—£25 Boarders £70—£100	8 of £20—£70	
Newcastle-on-Tyne: Armstrong College (affiliated to Durham University)	£18—£20	Some of £15—£20	Coal-mining and marine engineering very good
Manchester: Victoria University	£30—£35	4 of £35—£40	
Birmingham University	£30—£40	2 of £25	Faculty of brewing
University of Leeds	£15—£20	8 of £20—£50	Mechanical engineering strong
Liverpool University	About £30	20 of £20—£30	
University Colleges:			
Nottingham: University College	£9 to £18	Numerous	Very cheap. Excellent textile dept.
Bristol: University College	£13 13—£26 5	Numerous	
Sheffield: University College	Depend on course	7 of £25—£55	Metallurgy and tool-making good
Reading: University College	Depend on course	Various scholarships, exhibitions, and prizes	Evening classes, 5s.—£1. Agricultural dept. strong
Southampton: Hartley University College	12—15gs.	5 of £22—£34. 10 exhibitions	5s.—£1 10
Scotland			
Edinburgh University	At the Scottish and Irish Universities there are no comprehensive fees for the course. Students pay for each class separately, generally from 1 to 4 guineas a session.	Numerous	A few leaving scholarships
Aberdeen University		About 300 bursaries averaging £20	10 leaving scholarships
Glasgow University		Several hundred bursaries of £15—£35	Several leaving £40—£170
St. Andrew's University (to which is affiliated University College, Dundee)		100 bursaries of £10—£40 and 12 scholarships	16 leaving scholarships £60—£80
Ireland			
Dublin University: Trinity College		Numerous scholarships	
Dublin: University College	Boarders £75	3 exhibitions of £10. Prizes	
Belfast: Queen's College		Numerous scholarships	These three colleges form the Royal University of Ireland
Cork: Queen's College		Numerous scholarships	
Galway: Queen's College		Numerous scholarships	
Maynooth: The Royal Catholic College	Chiefly free		A Catholic seminary
Wales			
Aberystwyth: University College	£17	25 scholarships of £10 to £40	These three colleges form the University of Wales
Bangor: University College	£10—£15	" " " " "	
Cardiff: University College	13—28gs.	" " " " "	
Lampeter: St. David's University	£50 (boarders)	Numerous scholarships	A theological college

cost of £162 a year. It will be advisable, generally, to make an allowance of 50 per cent. of the fees stated for clothes, pocket-money, etc.

The fifth and sixth columns show the entrance and leaving scholarships given by the schools. The leaving scholarships given by certain of the schools in any one year depend upon the vacancies occurring, so that it is only possible to indicate the limits within which they vary.

LEADING HIGHER TECHNICAL COLLEGES OF THE UNITED KINGDOM

Institution.	Fees.	Remarks.
London.		
Battersea Polytechnic	According to course	Chemical and motor departments strong
Chelsea: South-Western Polytechnic	£12 10—£21	
Regent Street Polytechnic	5—12gs.	Fees very low. Linguistic department good
Stepney: East London College	10gs.	Evening class fees, up to 5gs. Chemistry good
Clerkenwell: Northampton Institute	About £15	Evening class fees, from 2s. 6d. upwards. Unique department of technical optics
Holborn: Birkbeck Institute	According to course	Chemical and commercial departments strong
West Ham: Municipal Technical Institute	8—12gs.	Evening class fees very low
Provinces.		
Redruth: School of Mines	Up to 6gs.	No evening classes
Derby: Municipal Technical College	10gs.	Evening class fees, 5s.—1 guinea
Plymouth: Municipal Technical College	8—12gs.	Evening class fees, 5s.—1 guinea
Sunderland: Municipal Technical College	Up to £8	Evening class fees, 5s.—£8
Wigan and District Mining	20—30gs.	Evening class fees low
Chelmsford: County Laboratories	£1 a week; county students free	No evening classes
Bristol: Merchant Venturers Technical College	10gs.	Evening class fees very low
Manchester: Municipal School of Technology	15—20gs.	Evening class fees, 2s. 6d.—3gs. A very fine college
Preston: Harris Institute	1 guinea—5gs.	Evening class fees, 2s. 6d.—10s.
Salford: Royal Technical Institute	5—6gs.	Evening class fees, 2s. 6d.—£1 5s.
Leicester: Municipal Technical School	£3—£9	Evening class fees, 3s. 6d. to 12s. 6d. Leather trades
Brighton: Municipal School of Science and Technology	15s.—15gs.	No evening classes
Birmingham: Municipal Technical School	From £1 10 upwards	From 2s. 6d. upwards
Swindon and N. Wilts. Technical Institution	2gs.	Evening class fees, up to £3
Coventry: Municipal Technical Institute	Up to 2gs.	Evening class fees, 5s.—10s. Watchmaking department good
Portsmouth: Municipal Technical Institute	£6 6	Evening class fees from 5s. upwards
Hull: Municipal Technical School	Up to 15gs.	Evening class fees from 2s. 6d. upwards
Bradford: Technical College	Up to 15gs.	Fees low. Mechanical engineering and textile departments good
Halifax: Municipal Technical School	From 4gs. upwards	Evening class fees, from 2s. 6d. upwards
Huddersfield: Technical College	5—9gs.	Fees low
Sheffield: Technical School	Up to 18gs.	Unique metallurgical department
Swansea: Technical College	Up to 15gs.	
Camborne: Mining College	Up to £10	Evening class fees, 3s. 6d. to 8s. 6d. The premier practical mining school
Scotland.		
Glasgow and West of Scotland Technical College	10gs. Numerous Bursaries of £25. Students are eligible for the Carnegie Trust Bursaries	3 leaving scholarships £30—£100. Probably the finest technical college in Great Britain
Edinburgh: Heriot Watt College	Fees low	Several free places
Glasgow: The Athenæum	According to course	Literary and commercial
Aberdeen: Robert Gordon's College	£7	Low fees

Neither can we in every case assign a definite value to the entrance scholarships, as the emolument is sometimes made up by reduction or remission of fees and the like. Many of these scholarships provide simply free education. These are described in the table as "free."

The values assigned to the scholarships are in every case annual ones, and the duration of the emoluments is, in the case of entrance scholarships, generally for the term of the school career, and in the case of leaving exhibitions, for three or four years.

Universities and Technical Institutions. Other tables show the university and technical institutions of the British Isles. The technical colleges not infrequently give literary courses, and nearly all of the universities provide a technical training, so that the distinction

OTHER LEADING DAY AND EVENING TECHNICAL SCHOOLS IN ENGLAND

In Scotland there are Municipal Evening Classes in all the large towns.

Institution.	Fees and Remarks.
Day.	
Finsbury Technical College ..	Electrical dept. good, 6 scholarships
South Shields: Marine School ..	1 guinea—4gs.
Stroud: Science and Art School ..	7s. 6d.—30s.
Bridgenorth: Foster Memorial Technical School	10s.
London: Evening. (In these institutions the fees are from 2s. 6d. upwards)	
Borough Polytechnic	Building trades; baking
Northern Polytechnic	Excellent workshops
Finsbury: Sir John Cass Technical Institute	Metal work
St. Bride's Foundation Institute	Printing school only
Strand: Bolt Court Technical School	L.C.C. photo-process (printing) school
Wandsworth: Technical Institute	
Woolwich Polytechnic	
Provinces: Evening.	
Darlington: Technical College ..	3s.—10s.
Blackburn: Municipal Technical School	3s.
Bolton: Technical School	2s. 6d.—15s.
Provinces: Evening.	
Burnley: Municipal School of Art and Technical Science	2s. 6d.—1 guinea
Bury: Municipal Technical School	5s.—£2 10
Ashton-under-Lyne: Heginbotham Technical School	From 3s.
Darwen: Municipal Technical School	5s.—15s.
Liverpool: Municipal Technical School	2s. 6d.—£1
Oldham: Municipal Technical School	5s.—10s. 6d.
Rochdale: Municipal Technical School	2s. 6d.—£1 5
St. Helens: Municipal Technical School	3s. 6d.—£2
Warrington: Municipal Technical Institute	2s. 6d.—15s.
Lincoln: Municipal Technical School	5s.—15s.
Norwich: Technical Institute ..	3s. 6d.—£2
Newcastle: Rutherford College ..	2s. 6d.—15s.
West Bromwich: Municipal Science School	Up to 10s. 30 free places
Longton: Sutherland Technical Institute	2s. 6d.—10s.
Wolverhampton: Municipal Science and Technical School	Some free places 4s. 6d.—12s. 6d.
Bath: Technical School	Some free places
Dewsbury: Technical School ..	2s. 6d.—7s. 6d.
Leeds: Institute of Science and Art	5s.—10s. 6d.

is often nothing more than the powers possessed by the universities of granting degrees. Where no special fees are stated it may generally be assumed that a university course costs from £25 to £35 a year, and a day course at a technical college from £8 to £15 per annum. Evening classes cost from 2s. 6d. to 25s. the course, according to the number of hours' work done and the apparatus used. The charge generally works out at about 1d. per hour.

These colleges draw their students from a much wider area than do the secondary schools, and many of them have some particular department of peculiar excellence, attended by students from all parts of England and beyond. Thus, while a Tyneside boy would naturally seek a technical training at the Armstrong College, or a Sheffield boy at the University College, Sheffield, yet a student might well go from Sheffield to Newcastle to study coal-mining or marine engineering, or from Newcastle to Sheffield to seek a training in metallurgy and the manufacture of tools. Of all such departments we have endeavoured to give some account in the last column of the table.

Employers and Technical Education. A question of growing importance to consider in the selection of a technical college is the relations subsisting between the college authorities and the local employers of labour. These relations vary widely. It was, for instance, at one time, the general habit of engineering firms, now happily abandoned, to regard men trained in the Cambridge engineering school as "theoretical men"—a crushing condemnation—while the leaving certificate of certain other institutions was accepted at something more than its face value.

There is a growing tendency at present among practical men to esteem highly the value of a theoretical training, and the American system of half-time training is being slowly adopted in this country. Among London technical schools, the Northampton Institute in particular deserves credit for an arrangement, made possible by the great interest in technical education taken by Messrs. Yarrow, under which students may spend six months in each year of a four years' course under instruction, and six months in the workshops.

Efforts are being made to create a similar good understanding in some of the provincial centres, and there is reason to hope that the next few years may see a great advance in the scientific training of experts in every technical department and in that of engineering in particular.

THE RACES OF THE WORLD

Relation of Anthropology to Other Sciences. Typical Skulls. Cranial and Facial Measurements. Stature. Ethnology, the Science of Races. Books on Biology

Concluded from page 1707

By Dr. GERALD LEIGHTON

UP to this point we have been tracing the means by which animals and plant species arose and became what they are, the whole process of organic evolution culminating in the production of man. We have finally in this course of Biology to look for a little at man as a species, and observe how the species is divided into a number of very different varieties, inhabiting various parts of the world, each with habits of body and mind peculiar to themselves. This is the study of Anthropology, the science of man.

Such a science, it will be seen at once, is related to almost all other sciences. It is closely connected with Zoology and Physiology on the one hand, and, of course, is bound up with the study of History and Theology on the other. It also touches the study of comparative anatomy, the comparison of the structure of man with that of the higher animals, which in this work will be dealt with in NATURAL HISTORY. Other points that are raised come into the realm of PSYCHOLOGY, and will be found in that section. Here we shall consider man chiefly from the aspect of Ethnology, taking for our study the typical examples of the principal races of mankind.

Physical Characters. In comparing the characteristics of living races of mankind, the points which are usually taken for comparison and contrast are the colour of the skin, the hair, the eyes, the size of the body and its proportions, the features of the face, and, above all, the detailed measurements of various parts of the skeleton. From the last source are compiled what are termed the "anthropometric tables."

Of all the body measurements, those of the skull are of greatest importance in Anthropology. This is accounted for in part by the fact that the skull contains the brain, and it is largely in brain quantity and quality that races of men differ. It must be remembered, however, that a large skull does not necessarily mean a brain of corresponding size or quality. The two parts of the skull, from this point of view, are the *cranium*, or brain-box, and the *face*. The cranium is estimated by taking the measurements of its capacity, its circumference in various directions, and the segments of the circumference. The dimensions of the face are also measured as to its total size and the size of different parts in relation to each other.

The skull may be judged in two ways—by a simple inspection, and by exact measurements. The former method, or cranioscopy, gives us certain views of the skull—*viz.*, from above, from the side, giving the profile, from behind, and from below. Each of these views shows its own special points for comparison with other skulls. Actual measurements of the skull are termed those of craniometry. The degree of brain development is estimated by the capacity of the cranium, a certain deduction of space being made for other structures which are also present in that cavity. Various methods are adopted for estimating this capacity, such as filling the cranium with No. 8 chilled shot, and then pouring the shot into a graduated measure. In this way it is found that a normal human cranium has a capacity varying from 1,000 to 1,800 cubic centimetres. Something depends upon the sex, so that skulls of the same sex must be taken for comparison, the mean capacity of the female skull being about ten per cent. less than that of the male cranium.

The Groups of Skulls. Taking the capacity of the cranium as a basis of classification, skulls have been divided into three groups—the smallest, or Microcephalic (below 1,350 cub. cent.); the medium, or Mesocephalic (between 1,350 and 1,450 cub. cent.); and the largest, or Megacephalic (all above 1,450 cub. cent.). The distribution of these may be shortly indicated in a table, thus:

Microcephalic Races.	Mesocephalic Races.	Megacephalic Races.
Veddahs and hill-men of India Andamanese Australian aborigines Extinct Tasmanians Bushmen	American Indians Chinese African negroes Malays Polynesians	Europeans Japanese Eskimos Mongolians Burmese

The average cranial capacity in the European races is about 1,500 cub. cent. Sir William Turner, of Edinburgh University, who has made a special study of the skulls of the world, has recorded a male Scotch cranium of almost 1,800 cub. cent., as contrasted with a female Australian aboriginal cranium of only 900 cub. cent. The enormous difference between these two figures gives some idea of the evolution of the brain which has taken place since the first appearance of truly man-like animals. In the anthropoid apes the greatest capacity is about 500 cub. cent.

Length, Breadth, and Height of Skulls. By taking measurements of the length, breadth, and height of skulls, another method of classification is obtained, the chief point in which is the comparison of one of these measurements with the other. Thus, the length is compared with the width by assuming that the

length equals 100, and then representing the width as so much per cent. The result of this is termed an "index," and the so-called "cephalic index" is arrived at thus:

$$\frac{\text{Greatest width} \times 100}{\text{Length}} = \text{The Cephalic Index.}$$

This is the most important method of classifying skulls. It gives five groups of skulls, the technical names of which sound somewhat formidable, but are quite expressive of their meaning. By working out the above formula, it is found that skulls of different races fall into the following groups: Those below 70, hyperdolichocephalic; from 70 to 75, dolichocephalic; from 75 to 80, mesaticephalic; from 80 to 85, brachycephalic; and from 85 upwards, hyperbrachycephalic. Extreme variations beyond these figures are probably not normal skulls. The value of this method of classifying skulls is shown when it is applied to a number of skulls of the same race of men; thus, it is found that the skulls of Australian aborigines are remarkably dolichocephalic, while those of the Andamanese are brachycephalic, both of these representing very primitive types. Stated generally, America tends to have brachycephalic skulls, Africa dolichocephalic, whilst Asia exhibits all types. The following table from Professor Cunningham shows the distribution among the races:

Dolichocephalic.	Mesaticephalic.	Brachycephalic.
AMERICA.		
Eskimos Fuegians		American Indians Eskimos of N. Alaska
AFRICA.		
African negroes Zulus Kaffirs	Bushmen Akkas Egyptian sea-board	
ASIA.		
Veddahs Certain hill tribes of India	Japanese Chinese	Malays, East Indian Islanders Andamanese Burmese Tartars Mongols
POLYNESIA.		
Melanesians	Mixed Races.	Polynesians
EUROPE.		
Mediterranean seaboard Isles of Italian Seas Sweden Norway	Greeks Turks French Germans Danes British	Lapps. Finns, North Swedes North Norwegians Poles Russians Hungarians Bohemians Austrians

Facial Measurements. Just as the cranium is taken as a basis of measurements, which enable us to group skulls together, so the face region is also utilised. It is, of course, obvious to all that the faces of different races are very characteristic. The forehead, the eyes, the nose, all are of great interest from this aspect. And just as certain skull measurements give a cranial index, so others give a "facial index." This is arrived at by a percentage comparison of the length and width of the face, according to which "high faces" are above 90, and "low faces" below 90. Most Europeans have high, or narrow faces; but Mongols and Eskimos have low, or broad faces. The lower jaw is also a very characteristic part of the face. Faces in which the jaw projects in a marked manner are termed "prognathous," but this appearance depends to a great extent upon the nose also. Calculations of the height and width of the nose give a "nasal index," according to which a skull exhibits narrow nostrils (leptorhine), as the English; medium nostrils (mesorhine), as the Chinese; or broad nostrils (platyrhine), as the aboriginal Australian.

Similarly, the measurements of the orbit give an "orbital index," and those of the palate a "palatal index."

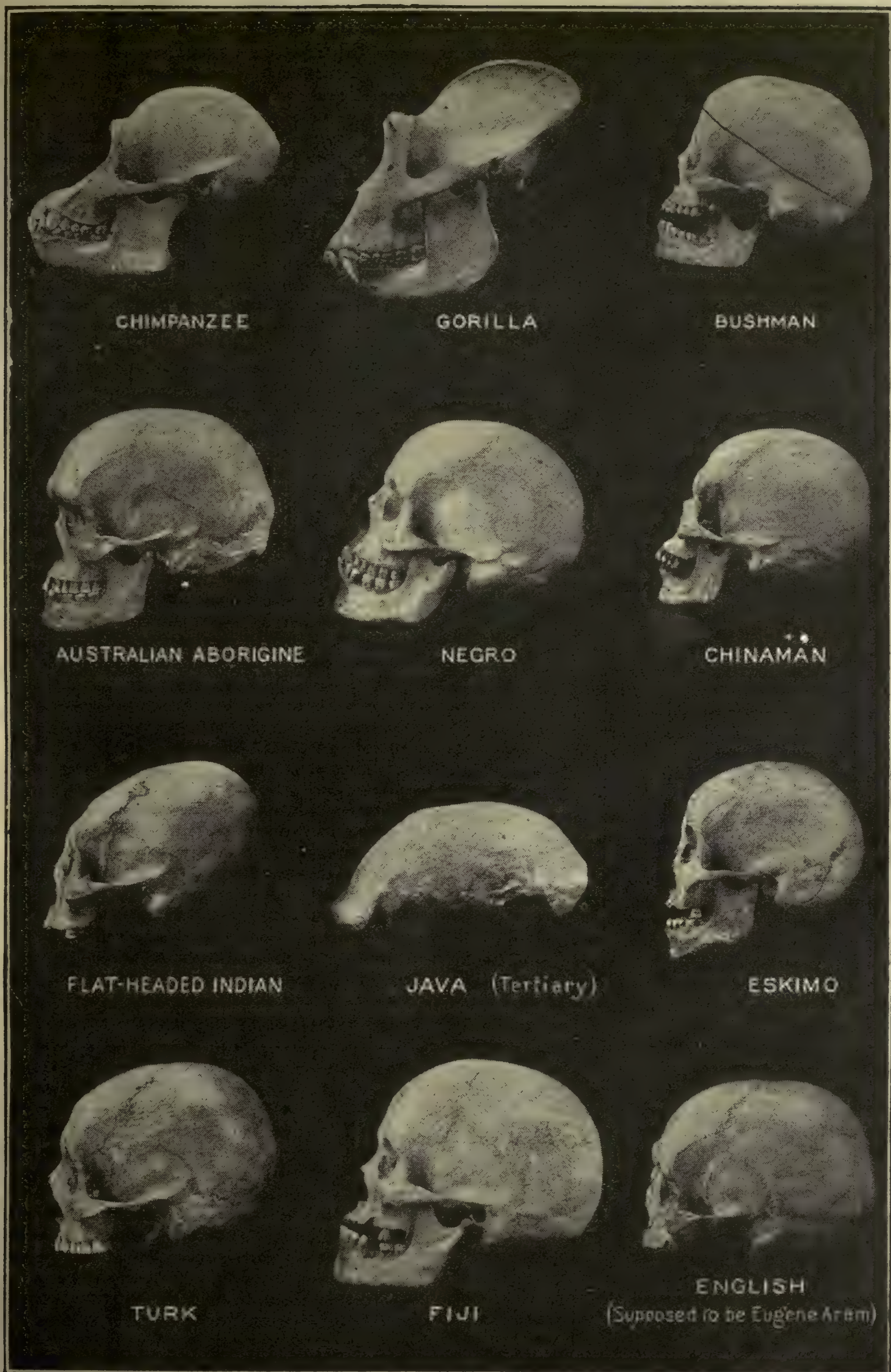
The Face and Cranium Together. If the measurements and shapes of the face be now considered together with those of the cranium, instead of separately, as above, we obtain an expression of the relative projection of the face in front of the cranium, which is what gives a skull its general appearance when simply judged by looking at it. In many animals the face projects very prominently, as in the ape and horse. They have "prognathous" skulls. This is also characteristic of the lower races of mankind, such as negroes and Australian aborigines. When the projection is only slightly seen, as in the case of Europeans, the skull is said to be "orthognathous"; where the projection is between these two extremes, it is termed "mesognathous." This "gnathic index," so important in describing a skull, is arrived at by measuring the distance between the basion to the base of the incisor teeth, multiplying this by 100, and dividing the product by the distance from the basion to the root of the nose. Below 98, skulls are orthognathous; from 98 to 103, mesognathous; above 103, prognathous.

The following tables exemplify the arangement of skulls in the groups just described:

Leptorhine (Narrow nostrils).	Mesorhine. (Medium).	Platyrhine (Broad).
English Scotch Parisians Basques (French)	Chinese Lapps Peruvians Mongols Javanese Polynesians	Hottentots Tasmanians Negroes Australian aborigines New Caledonians (The black races)

Orthognathous.	Mesognathous.	Prognathous.
Europeans Bushmen	Chinese Japanese Malays Maories Polynesians Andamanese	Hottentots Australian aborigines Tasmanians Melanesians Kaffirs Negroes

The Stature of Races. In addition to the racial differences already indicated, there is the question of stature, a character in which races exhibit most marked variations. The Akkas of equatorial Africa are the smallest, and



TYPICAL SKULLS

in them the height of both males and females is below 4 ft. The Bushmen, Lapps, Eskimos, and Veddahs all fall below the average height of 5 ft. The differences in stature are very largely due to differences in the length of the bones of the legs, hence, when a number of people of different heights sit down, their heads appear to be almost at the same level; standing up the varying heights are at once obvious. Various methods are used to determine and compare statures. The length of the shin-bone added to that of the thigh-bone, the result multiplied by two, and to this result one inch added, gives a fairly accurate estimate.

The tallest races are the Norwegian, Scottish, Irish, English, German, French, Swedish and Russian.

Many other measurements of various bones are used for making racial comparisons; but as it is unnecessary to enter into them here, we may proceed to glance now at the races themselves and some of their predominating characteristics.

ETHNOLOGY

The science of races deals with the external features by which races are distinguished, some of which we have described above, and also with their intellectual and moral capacities and peculiarities, as well as with their manners and customs, their language, origin, social organisations, relationships, and distribution. It is sometimes far from easy to draw a hard-and-fast line between two races, the characters of the one frequently exhibiting gradations into that of the other, the result being that various classifications of mankind have been proposed. As any classification is merely a matter of convenience, and depends upon the particular method adopted, we need not restrict ourselves here to any special arrangement.

The study is naturally one of great antiquity, the term anthropology being used first by Aristotle, chiefly in a philosophical sense. He discusses man as an animal in his "History of Animals," and deals with his psychical as well as his physical nature. The modern study of the subject dates from the publication of Darwin's "Origin of Species," and especially from the time of the discovery of proof of the great antiquity of man. The physical aspect of Anthropology is that of the relation of man structurally to other animals, and the relation structurally of various races. Ethnology, while including this to a certain extent, also studies the mental side of human nature.

As regards the position of man in the animal kingdom, it may be noted that Linnæus placed him among the *Primates*, while Cuvier gave him an order (Bimana) to himself. The majority of Zoologists at the present time place man in the order Primates, along with the monkeys and lemurs. The comparison between man and these animals is dealt with in another part of this course, which should be studied in connection with this subject. [See NATURAL HISTORY].

The Australian Aborigines. The aboriginal inhabitants of the continent of Australia as well as those of Tasmania (now extinct) exhibit a very primitive and rude state of civilisation. They dwell largely in the open, building no permanent dwellings, and occupy themselves in the pleasures of hunting and in warlike pursuits. They practise no form of agriculture, and their weapons and implements are few. Among the former is the well-known boomerang. Their clothing is of the scantiest, and their food includes fruit, fish, roots, and products of the chase, also such out of the way articles of diet as lizards, ants, caterpillars and worms.

Physically, the skulls are of the dolichocephalic type, and the face prognathous, the jaws protruding. The nose, which is narrow at the root, widens out below, ending in wide nostrils of the platyrhine type, and the mouth is wide also. There is a thick covering of hair on the body, that on the head being frizzly. The skin varies a good deal in colour, from black to coppery red. Many of the customs of this race are very interesting, especially those relating to marriage. Wife-stealing is common, owing to the fact that a man must not marry within his own tribe. The language is highly complicated.

Intellectually, the Australian aboriginal devotes most of his energies to the procuring of food, and in that sphere, where the success depends upon the actueness of the senses, he is extremely clever. As a tracker of prey he is unrivalled, and is by no means a bad cook.

Indications of an elementary artistic faculty are seen in the rude sketches of sharks and lizards on the walls of caves and on the surface of rocks.

There is no government except family and tribal law, and the code of morality is limited to the ideas of property. The religious ideas of the people appear to be mainly a dread of demons, but it is extremely difficult to find out what they really think. They are unable to calculate in abstract numbers beyond five. The aborigines are disappearing before the advance of the white man, being driven more and more from the best land into the deserts and bush of the interior, while those who remain in touch with civilisation acquire with rapidity the least desirable of its products.

The Papuans. This race, which inhabits New Guinea and other islands, is regarded by some as the most nearly allied to the Australian aborigines. Their characteristics are described by Mr. Alfred Wallace in his "Malay Archipelago." They are well made physically, with regular features, intelligent black eyes, curly hair, thick lips, large mouth, nose flat beneath, with large nostrils, and a dark brown, or almost black skin. The colour depends on the exact locality inhabited, being darkest in New Caledonia, dark brown in New Guinea, blue-black in Fiji. Mr. Wallace says that "they are superior in stature to average Europeans, but have long and thin legs, and the splay foot of the negro. They are copper-coloured, of a light, active build, often with very good features, which they paint; but the men's teeth and mouths are much disfigured by

constant use of betel-nut. The hair is usually worn frizzled out into a huge mop. The women's hair is always cut short. Their weapons appear to be spears, swords, clubs, and stone hatchets, but no bows and arrows were seen amongst them. Occasionally human jaws and spinal bones are worn as bracelets and ornaments. They appeared to take pleasure in making us understand that they had eaten the original owners of the bones; but these bones, as well as the few skulls exhibited in their villages, appeared to be of ancient date. The houses are built after the Malay fashion, on poles raised five or six feet above the ground, and consist of one large apartment."

The skull is high and narrow, the jaws protruding, the lips large. Agriculture is followed to a certain extent, fields and gardens being fenced in. Intellectually and morally the Papuans are able to attain to a fairly high standard, and both sexes, as a rule, wear some clothing round the loins. Little is known of their religious ideas, which, however, include a belief in a future state. Cannibalism is their greatest reproach. The inhabitants of Fiji are the most civilised. They have some capacity in artistic work, and make pottery. Captain Moresby concluded from his experiences that the Papuans are a promising race, and, under the influence of civilisation, have a good future before them.

The Mongoloid Races. A number of races are grouped under this general heading, including the Polynesians, Asiatics, Malays, Chinese, Japanese, Turks, American aborigines, and many other allied races.

THE MALAY RACE. The Malays are divided into Asiatic and Polynesian. None of them are absolutely black, the Asiatics being yellowish. All of them have straight hair, which is scanty on the body, and prominent cheek-bones.

THE POLYNESIAN MALAYS. These include the Maories of New Zealand—a fine race of men, who, though diminishing in numbers on the first contact with civilisation, now appear to be slightly on the increase again. They were originally cannibals, and extremely warlike. Indeed, as fighters, they were unsurpassed. So well have they adapted themselves to English methods that they send their own representatives to the Parliament of the colony, and generally have proved themselves a highly intellectual race. The language, like all Polynesian languages, is most agreeable in sound, being rich in vowels and poor in consonants. It is polysyllabic.

SOUTHERN ASIATICS. In this group are the Chinese, Burmese, Siamese, Annamese, Tibetans, and others. Their common characteristics are a yellow skin, oblique eyes, and straight black hair, which is slight in amount on the face and body. Many of them have attained a high degree of civilisation, and have the inventive faculty well developed. Their language is monosyllabic. They do not readily adopt Western methods, being in this respect markedly different from the Japanese.

JAPANESE AND KOREANS. The languages of these peoples show considerable structural differences from the Chinese, from whom, however, they received their earlier civilisation, though they are now rapidly adopting European methods in both civil and military life.

NORTHERN OLD WORLD MONGOLOIDS. In this group are the Tungus (to which belong the Manchus, the conquerors of China and the establishers of the dynasty), the true Mongols, or Tartars, the Turks (including the Osmanlis of European Turkey), the Finns, and Samoyedes. All of them somewhat resemble the Indo-Chinese physically, but they live more by fishing, hunting, and cattle-breeding. Classed with the Finns are the Lapps, the Hungarians, and the Bulgarians.

Amongst Northern races whose origin is doubtful are the inhabitants of Saghalien, and the Ainos, the oldest inhabitants of Japan. They are characterised by general hairiness, which is the more remarkable in that they are in the midst of smooth-skinned races.

Inhabiting the shores of Behring's Straits are a number of North Asiatic and American tribes, of which the Eskimos are most important. They are intelligent, of low stature, with oblique eyes, and broad, flat faces.

The American aborigines appear to be allied to the Mongol race, and probably crossed over originally from Asia. Reddish-copper colour predominates, with a more prominent nose. Most of them are hunting peoples, now rapidly disappearing. Among them are the famous Apaches and Sioux, and the Caribs of Central America.

The Aborigines of India, or Dravidians. The tribes included here have, as a rule, a very dark skin approaching to quite black, long, black, curly hair, abundant hair on the body, lips like those of negroes, but not a prominent jaw.

Bushmen and Hottentots. In these South African tribes the hair is matted, and there is very little on the body; the jaws are somewhat prominent; the lips rather less prominent than those of negroes; the nose snub-shaped, the build slim, and the stature low, particularly in the Bushmen. The colour is yellowish-brown. The peculiarity of the languages is the clicking sounds. These people are by no means unintelligent. Cattle-breeding has long been their occupation, and before Europeans went to South Africa they used to smelt iron and work in metals. They used poisoned arrows for hunting.

The Negroes. It is a great mistake to consider the negro as identical with the African, the southern limit of the negro being the south margin of the Sahara, south of which is the country of the Hottentot and Bushmen. The typical negro is too well known to need detailed description, but, at the same time, the type is not often seen. The skin is black, the hair woolly, the lips thick, the lower part of the face protruding or prognathous, the forehead low and receding, and the skull bones are thick. But various negro races differ greatly in external characters, the colour passing through every shade, from ebony black to yellow. The nose

is usually broad and flat, and there is but little hair on the body or face. Amongst them are the Kaffirs of the south-east, a brave, intelligent, and warlike race, who are also cattle-breeders; the Bechuanas, who dwell more inland; and the Ashantees of the Soudan, a cruel race, but intelligent, exhibiting considerable skill in the manufacture of sword-blades and cotton cloths. It is in the Soudan that the typical negro is found.

The religion of negro tribes, in the absence of introduced Mohammedanism, is practically a low form of fetish worship, with idols of wood and stone, there being, however, under it all the idea of a Supreme Being. Their religion is entirely one of fear of good and evil spirits, human sacrifices being offered up to propitiate their deities. They are polygamous. Many tribes were reduced to the lowest state of degradation by the iniquities of the slave-trade.

The Highest Human Races. Amongst what are termed "the Mediterranean Nations," which include all the Europeans who are not Mongols, is found the highest type of living men. In the Northern nations the skin and complexion are very fair, in the Southern races the skin is darker; whilst in North Africa and Eastern Asia it is yellowish, brown, or red. The bridge of the nose is always high, the jaws are never prominent in a typical case, and the whole contour of the face is regarded as expressing the highest nobility of character to be found in mankind. Included in these Mediterranean nations are the *Hamites* of North and East Africa, amongst which are the Berbers, the ancient Egyptians, and their modern representatives, the Copts, and the Nubians and Abyssinians. They were the first of the Mediterranean nations to attain to high civilisation, and the degree of this can be estimated by what we know of the ancient Egyptians and their monuments. Then there are the *Semites*, including the Jews, Arabs, Abyssinians proper, and the ancient Phœnicians, Assyrians, Canaanites, and Babylonians. The skin varied from slight darkness to deep brown, with high aquiline nose. Their civilisation was of a high order from an early age, and has contributed much to that of modern Europe.

The Aryan Race. Of deepest interest and importance to us, as being that to which we ourselves belong, is the *Aryan*, or *Indo-European* family. Two branches have long been recognised, the European and the Asiatic. The European includes the Germanic, or Teutonic nations, such as the English, German, Dutch, Danes, Norwegians, Swedes, etc.; the Romance nations, or French, Italians, Spaniards, and Portuguese; the Slavonians, or Russians, Bohemians, Servians, etc.; the Greeks; and the Celts of Brittany, Wales, the Scottish Highlands, and Ireland. The Asiatic section of the family is represented by the Hindoos, the Afghans, the Beloochis, the Persians, the Armenians, and the Kurds. "The Indo-Europeans have the physical characteristics of the Mediterranean races in the fullest purity, while among the inhabitants of Europe the remarkable peculiarities of fair hair and blue eyes are frequent. The New World is now largely occupied by European Aryans, and probably the aboriginal races will, in time, entirely disappear. Among the Greeks, ancient and modern, the highest type of physical beauty is common. We meet with fair, ruddy, and dark complexions, with golden, auburn, and dark hair, with blue and dark eyes. The Spaniards, Italians, and natives of the South of Europe generally, have dark complexions, eyes, and hair, with frames less robust than the members of the Teutonic stock. The Germans were anciently described as tall and robust, with fair complexion, light or red hair, and blue eyes, and to some extent this description still holds good of the Germanic peoples. The physical characters of the Slavonians present little that is peculiar. The Russians, especially in the north, are fair, with light brown, flaxen, or red hair. The Persians, among Asiatic Aryans, are well known as a remarkably handsome people, with regular features, long, oval faces, and large black eyes. The Mahrattas of Central India have proved themselves a warlike and vigorous race. Physically, they are said to be undersized, and not well formed."

Odd Races in Europe. Probably the oldest inhabitants of Europe are the Basques of the North-east of Spain and South-west of France. The physical characters of these peoples, together with those of some Caucasian tribes, are similar to those of other races in the Mediterranean group, but their language sets them in a group apart. Their origin is doubtful.

In our general outline of the living races of mankind it has been impossible to do more than merely indicate how man has become differentiated into the number of races and varieties mentioned. Almost every race has a book to itself; some, indeed, have very many, and to these we must go for a detailed study of races and nations. Here we merely wish to emphasise the great variety which exists, and the profound variations which occur in physical characteristics, and no less in mental and moral qualities. All these are the product of organic evolution and natural selection of some form; each is adapted to some special environment to which it has attained by the survival of the fittest, and in the ultimate struggle for existence among the nations some are dying out, whilst others are becoming supreme.

And here we must leave man as the animal, and turn our attention to him as a moral and intellectual being, endowed with capacities and hopes far transcending those of his ancestors, embracing a destiny to be wrought out by

Exultations, agonies
And love, and man's unconquerable mind.

What to Read on Biology. It may be hoped that the course of BIOLOGY, which at this point comes to an end, may have aroused in the minds of at least some readers sufficient interest in the great problems of life to make them desirous of carrying their studies further. Such, indeed, has been the object constantly before the mind of the writer. No course of

this kind can pretend to do more than point the way; it requires a library to follow out the side roads and the bypaths. Some of the main roads are dealt with in other portions of the SELF-EDUCATOR—*e.g.*, NATURAL HISTORY, GEOLOGY, etc.—but others must be left for each individual student to follow up in accordance with the special aspect of the subject which appeals to him most. It may, therefore, be of service to conclude by giving a short bibliography, selected from the many excellent works on various aspects of biology, which the reader who wishes to trace out the great principles already discussed into more detailed branches can study to the best advantage. We may divide these under some of the headings which have guided us in the former parts of this course.

Books on the Great Problems of Biology. Charles Darwin's name at once suggests itself, and every student of the subject should make himself familiar with the following works of Darwin: "Origin of Species" (new edition, 1902); "Descent of Man" (new edition, 1901); "Variation of Plants and Animals under Domestication" (1868). In addition the student should read some of the works of Alfred Russell Wallace, Herbert Spencer, and Haeckel. For example: Wallace's "Darwinism" (1889); Spencer's "Principles of Biology"; Haeckel's "Generelle Morphologie." Among other works and writers the following may be suggested: Karl Pearson's "Grammar of Science" (1900); Weismann's "The Evolution Theory" (translated 1904); J. A. Thomson's "The Science of Life" (1899); Mivart's "The Genesis of Species" (1871).

Textbooks on Zoology. The student who turns his attention to the forms of animal life, their distribution, and habits, will find a large number of textbooks on zoology, from which he may select: Huxley's "Anatomy of the Invertebrated Animals" (1877); Huxley's "Anatomy of the Vertebrated Animals" (1871); Parker & Haswell's "Textbook of Zoology"; J. A. Thomson's "Outlines of Zoology"; Nicholson's "Textbook of Zoology"; Mudge's "Textbook of Zoology"; Ray Lankester's "Treatise on Zoology" (being issued in 10 vols.), and many others. The more modern ideas, facts and speculations concerning the problems now interesting the biological world will be found discussed in recent works on Variation and Heredity, two aspects upon which we have laid great stress in this course. It is to these works that the student must go to bring himself up to date in biological thought, because great conceptions have been elaborated in the last few years, and the trend of thought is changing rapidly in various directions, due to the actual facts which have been collected upon Variation and the actual experiments which have been and are being made upon Heredity.

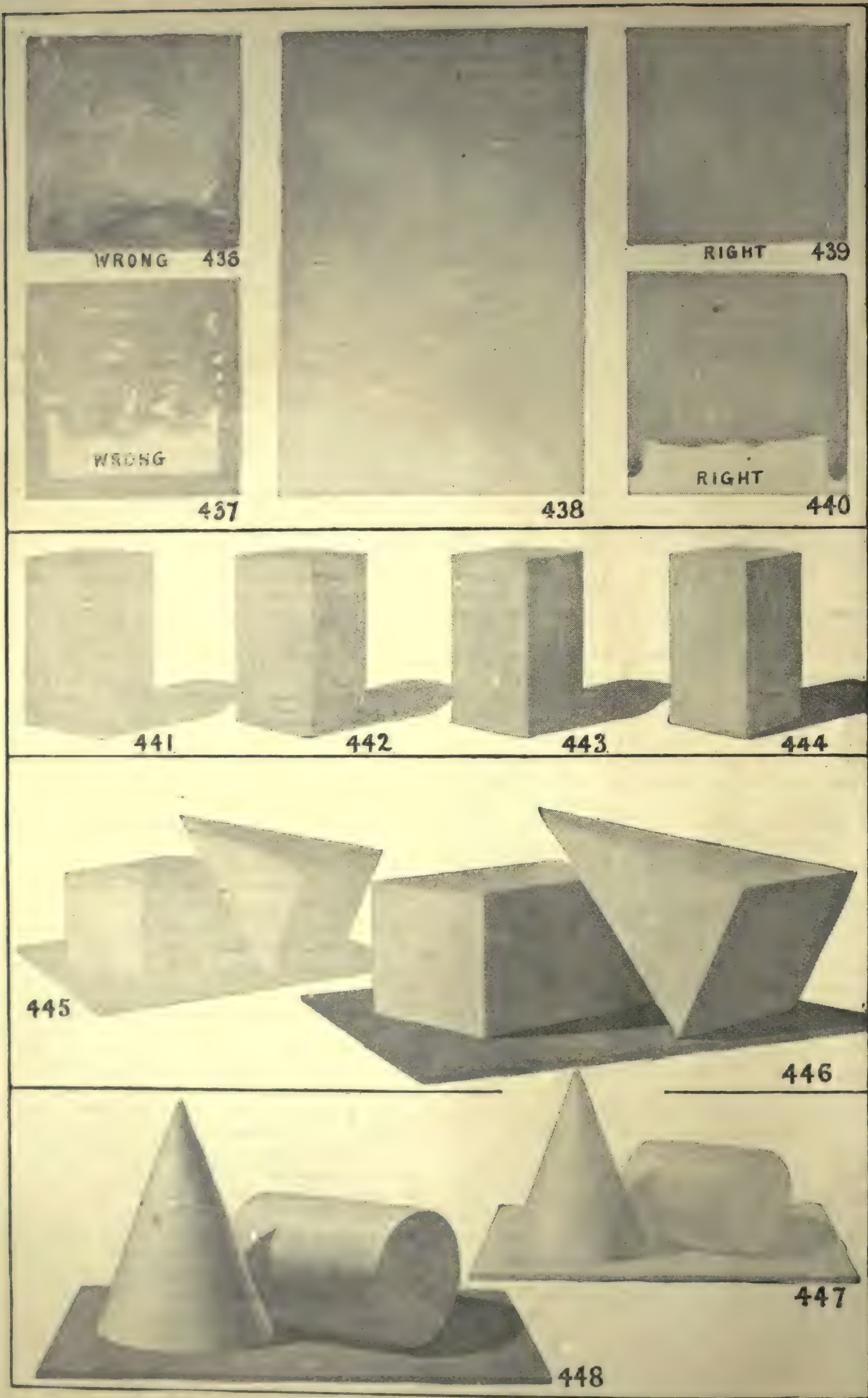
Books upon Variation. Two books upon Variation may be suggested: W. Bateson's "Materials for the Study of Variation," Vernon's "Variation in Animals and Plants."

Books on Heredity. The following are the authoritative books on Heredity: Archdall Reid's "Principles of Heredity" (2nd. ed. 1906); J. A. Thomson's "Heredity" (1904); Weismann's "Essays on Heredity"; Weismann's "The Germ Plasm"; Cossar Ewart's "The Pennycuik Experiments." Much of the most recent work is to be found only in papers contributed to the various scientific societies, such as the Royal Society and the British Association; indeed, there is no one book which gives a general survey of every aspect of the question, nor could any one book be up to date at present, because of the vast amount of experimental work now in progress. For this reason the publications of the various scientific societies must be consulted from time to time. Reference to special articles in the "Encyclopædia Britannica" will give information on some recent points.

Miscellaneous Books. Lastly, we may append a list of works, the titles of which are a sufficient indication of their contents, and from which the reader may choose. E. B. Wilson's "The Cell in Development and Inheritance" (2nd ed. 1902); Geddes & Thomson's "The Evolution of Sex"; Francis Galton's "Natural Inheritance" (1889); C. Lloyd Morgan's "Animal Life and Intelligence"; G. J. Romanes' "Mental Evolution in Animals" (1883); F. E. Beddard's "Textbook of Zoo-Geography"; H. F. Osborn's "From the Greeks to Darwin" (1894); Nicholson and Lydekker's "Manual of Palæontology"; Herbert Spencer's "Principles of Biology" (1864-6).

This is merely a selection from a vast number of works which might be cited if space permitted, but it covers most of the ground which will be required by the reader who wishes to pursue this course further. It need hardly be said that every group of animals has its own library as well, and the reader will have no difficulty in finding a book upon a special part of the animal kingdom in which he may be specially interested. The student of biology is earnestly advised to read first the old masters—especially Darwin—but not to rest content with learning what they thought and said, but to continue his researches into the work of present-day biologists, many of whom are engaged in throwing absolutely new light upon many problems which a few years ago were dim and obscure. The student who does this may rest assured that he will reap an intellectual harvest which will more than repay the effort involved, and which will give him an interest in Life such as can be obtained in no other way.

Biology concluded



SOME GRADUATED EXAMPLES OF DRAWING IN INDIAN INK OR SEPIA

LIGHT AND SHADE

Drawing in Monochrome with Sepia or Indian Ink. Preparing and Stretching the Paper. Flat Washes. Gradations. Simple Objects and Groups

Continued from page 1749

By WILLIAM R. COPE

Drawing with Sepia or Indian Ink. This kind of shading may be begun when the student has had a fair amount of practice with stumping chalk, for he will then have gained considerable experience in judging tone values, etc., and so will be able to lay on a wash of colour which will require little or no alteration, thus ensuring freshness and cleanliness, and avoiding a muddy and sloppy kind of work.

Stretching the Paper. Before beginning to draw, in order to avoid cockling of the paper, the latter should be wetted thoroughly with clean water, stretched upon a drawing-board, and the edges only of the paper pasted down about an inch or an inch and a half wide all round. While it is drying, it should be placed *in a horizontal position*, or one or more edges may not stick down firmly, and the paper would thus have an undulating surface, quite useless for good work. Drawing-boards specially made for stretching paper without pasting down may be obtained. Or, again, the student may purchase paper already stretched on cardboard, and although rather more expensive, it is, nevertheless, admirable for almost any work in water-colour. The paper should be Whatman's or O. W. S. "not" surface.

Laying on a Flat Wash. This gives much trouble to most beginners, and yet it is a very easy matter if done in the right way.

Have two good sable-hair brushes (Nos. 5 and 8), and a "wash" brush about an inch wide; also two jars of clean water, one of which should be kept as clean as possible, and the other used for rinsing the brushes. Damp the surface of the paper all over with clean water before putting on a wash of colour, which should not be done until the "shine" of the water has passed away. Experiment will teach more than words when the paper is in the right state. Mix plenty of colour to the required tone; use as large a brush as possible, full of colour; begin with horizontal strokes at the top of the drawing, which should be tilted at a suitable angle (about 35°), so that the colour runs down, and makes a pool all along the bottom edge of each wash across [see **440**]; continue this process until the whole surface is covered. Stir up the colour in the dish thoroughly each time a fresh brushful is taken up. Squeeze out the remaining colour in the brush on a sponge or rag, and absorb the final pool at the bottom by applying the point of the brush lightly to the superfluous colour to be soaked up. Fig. **439** shows how the wash ought to appear when finished, while **436** indicates what will happen if the wash is put on as shown in **437**.

A Gradated Tone. Fig. **438** shows a good and useful exercise in gradation of tones, which merge into one another without any definite line of demarcation. Such gradation is often required—in fact, more so than a flat wash—when objects having curved surfaces are being studied, and even flat surfaces frequently require gradation of tone, as explained previously. The student must, therefore, practise carefully and many times, until he is able to produce an appearance in his work similar to that shown in **438**.

Several different values of tones should be mixed ready in separate dishes. Then wash the paper all over with clean water, and when the "shine" has disappeared lay on the darkest tone of colour along the upper portion of the paper; keep a good pool of colour along the edge of each wash across, and also be sure to have the drawing tilted at the requisite angle. When two or three washes across have been made, take up some of the next lighter tone of colour, and put on two or three horizontal washes of that value. Then proceed with the other values in a similar manner. If the colour should be uneven—that is, streaky or blotchy—do not try to patch it up while it is wet, or it will make a bad matter worse. Wait until it is dry to make corrections, although none should be required if the foregoing instructions are implicitly obeyed.

Sepia Drawing of Simple Objects. Having learnt how to manipulate such values of tones, the student should take a rectangular block or box, make a careful drawing of it in pencil, then lay on a moderately light tone all over the drawing of the object and its cast shadow [see **441**]. This light tone should be equal in value to the apparent lightest tone of the object. It is generally best to put on light tones first. Do not make a study of a glazed or polished object yet, as there would be too many difficulties to contend with, owing to the many reflections on the surface.

Fig. **442** shows how the next stage should be executed, by putting on the next darker tone equal in value to that seen on the top surface of the block. The third stage [**443**] has a darker tone still only on the right-hand vertical surface and the cast shadow. Finally, the cast shadow is made darkest of all, as shown in **444**. The student should keep in mind the advice given previously about values of edges, etc., and endeavour to express them truthfully. The edges should be softened with a brush that has been dipped in the water and partially dried upon the sponge or rag, and one should be careful not to lose the correct shape of a surface or shadow.

449. WASH DRAWING (INDIAN INK) OF WINE-GLASS AND BANANAS

A Law for Shadows. As many beginners in drawing make errors when sketching the outline for shadows, it would be well for them to remember the following law. "*When a shadow falls on a plane which is parallel to the edge of the object which causes the shadow, the edge and its shadow will vanish to the same point.*"

Objects with Flat Surfaces. Now study a group such as is indicated in **446**. First make a correct drawing of the objects and their shadows, then spend a few minutes in ascertaining which is the lightest and which the darkest tone, what order the intermediate ones should take, and their relative values, whether there are any reflected lights, any gradations of tone, the varying values of edges, etc. Start shading by laying on the lightest tone all over the drawing, and next, the

450. WASH DRAWING (INDIAN INK) OF GROUP OF BOOKS

451. STUDY IN SEPIA OF ROMANESQUE ORNAMENT

second darker value, as shown in **445**. Proceed with each darker tone as in the preceding exercise. Note the subtle gradation on the vertical surface of the rectangular block where the pyramid causes a darker shade to appear.

Objects with Curved Surfaces. The next study introduces objects having curved surfaces [**448**], and here very great care is needed, and application made of the facts learnt when executing the exercise shown in **438**. Again most searching observation must be made concerning the drawing and tone values, etc. Do not be misled about the position of the lightest part of the cone and cylinder. It must be noticed that it is not quite on the extreme left-hand boundary of the cone, nor quite on the top boundary of the cylinder, but a little way inside each. The delicate and subtle tone on these light boundaries helps considerably to give the roundness of the objects as well as to suggest a space behind them.

Notice, too, the reflected light on the right-hand boundary of the cone, and the lower part of the cylinder, the peculiar shape of the shadow of the cone on the cylinder, and that the straight-edged part of the shadow of the latter vanishes in the same direction as the straight boundaries of the cylinder.

Begin shading with the lightest tone, as before, and afterwards with darker shades, blending them somewhat with one another as required, so as to obtain an appearance like that in **447**. With further washes, blending and softening them as needed, finish the drawing as shown in **448**.

Of course, it is not intended that the student should merely copy the drawings here given. He must study from objects, for that is the only true way of training one's self satisfactorily.

More Difficult Groups. In **449** we have a more interesting study, which, nevertheless, will demand still more observation and very great care in execution. The change from one tone to another is so subtle that only keen perceptive powers will see what ought to be seen. There is, too, the glazed surface of the wine-glass to be represented, with the strong high light and the other many various values of reflected light tones, all of which require special care in drawing and in giving the values of edges, etc. Notice the peculiar shape of the shadow of the wine-glass on itself, on the adjoining banana, and on the horizontal surface of the table. See how soft is the shadow's edge on the table. Be careful of the drawing and the tones of the dark markings on the skins of the fruit. There are many other facts which must be diligently sought, before a satisfactory representation can be made.

Start with the lightest tones again, and proceed with the others in proper sequence. Keep the colour fresh and clean. Do not scrub it about, or the work will soon have a muddy appearance. Some reflected lights may be

452. A WATER-COLOUR STUDY OF STILL LIFE

taken out with a partially dry brush while the colour is somewhat damp; this will avoid hardness of edges to such reflected lights. Once more, *study from the objects.*

A Group of Books. The group of books shown in **450** will make a capital exercise, and give scope for further training of the perceptive faculties, and skill in manipulating the brush and colour. When drawing such a group, great attention must be given to the law of apparent convergence of parallel receding edges, as well as to the tone values, etc. The brushwork must be as direct as possible, and this can only be so when the student has a clear idea in his mind of what he is about to represent. The work in this exercise should be done in a similar order to that of the preceding ones.

Sepia Study from a Cast. Fig. **451** shows a study in sepia from a cast of ornament which will make an admirable test of the student's ability to judge proportion and tone. The original drawing was 21 by 18 in. in size. The high lights in this reproduction, as in **449**, **450**, and **452**, are rather too dark.

A More Difficult Group. In **452** we have a much more ambitious and more difficult group, but still very interesting, and one which will give the student some idea of composition when arranging objects. It will be noticed that a background has been introduced which is rather low in tone, and many objects apparently lose their edges in places. The original drawing was 24 by 18 in. in size, again indicating how large the student's drawing should be. When a monochrome study as difficult as **452** can be executed satisfactorily, the student is well prepared to start ordinary colour work.

Continued

MOTION AND LOCOMOTION

The Three Orders of Levers in the Body. How the Erect Position is Maintained. Walking, Running, and Jumping

Continued from page 1712

By Dr. A. T. SCHOFIELD

MOTION in itself is no more a proof of life in a man than in a steam-engine; it is the method by which it is produced in man that differentiates him from a machine. Motion and locomotion are not the same. Motion is movement only, but locomotion is movement from one place to another; in walking we get both.

A great deal of motion takes place in the body apart from locomotion, although, in fact, the body as a whole does not change its place.

For motion or locomotion four structures at least are necessary as regards the mechanism. Something to be moved—the bones; a place where they move—the joints; machinery that moves them—the muscles; and a force that drives the machinery—the nerves; and all movements involving these structures take place according to mechanical laws. These, then, we will briefly consider.

A System of Levers. The principle with which we are most concerned is that of *leverage*, or movement by means of levers. A lever is simply a bar that lifts (French *lever*—to lift), which may be either straight or crooked, and made of any rigid substance, such as wood, iron, or bone. All our bones are used as levers or bars.

Now, as a rule, we can do so much more work with levers than we can do without them that Archimedes, who discovered their use, said that if he had a lever long enough, and a fulcrum to rest it on, he could move the world. If you see lying on the ground a piece of rock or a large chest that you cannot lift or move, get an iron crowbar—which acts as a lever—put a little block of wood on the ground, and rest the crowbar on this block of wood, and the tip of the crowbar under the rock or chest. By then pressing down the long end you can prise up the chest or rock, and perhaps turn it right over. The block of wood that supports your crowbar is the *fulcrum*. If you stir the fire with a poker between the bars, they form the fulcrum on which the poker, which acts as a lever, moves. In a see-saw the support on which the see-saw rocks is the fulcrum. In a pair of scales the beam acts as a lever, and the pivot in the middle on which it works, the fulcrum. In a lever there are two other things we must consider besides the fulcrum—the *power and the weight*.

The power *is the force that moves the lever*; the weight is the *object that is moved*. If you stir the fire, it is very easy to see that your *arm is the power*, the *grate-bar the fulcrum*, and the *coal the weight*. When you lift a chest or rock with a crowbar, in the same way your *arm again is the power, the stone the weight, and the ground or block the fulcrum*. In a pair of scales, again, whichever is the *heavier side* contains the power, because it moves the lighter one, and the *lighter one* contains *the weight*. In a see-saw the *heavier child is the power*, and the lighter one is the *weight*, or the one that is moved. The parts, then, in a lever are three in number. They are the *fulcrum* (F), or the fixed point on which the lever moves, which in the body is invariably a joint; the power (P), or the force that moves the lever; and the weight (W), or the object that is moved.

Orders of Levers. The orders of levers vary according to their relative position, thus:

WFP. is the first order—*i.e.*, when the fulcrum is in the middle.

PWF. is the second order—*i.e.*, when the weight is in the middle.

WPF. is the third order—*i.e.*, when the power is in the middle.

A pump is a capital example of the first order. Nut-crackers are in the second order; pushing open a door, or lifting a spadeful of earth, are in the third order.

Levers of the Body. Now, all three orders of levers are used in the body, although the third is undoubtedly the favourite, for a reason that will be evident.

Tapping the foot on the ground [101], raising the head off the chest, and straightening the arm, are examples of the first order, thus:

W.	F.	P.
foot	ankle-joint	muscles of calf
head	joint with spine	muscles of spine
hand	elbow-joint	triceps muscle

Standing on tiptoe is an instance of the second order. Thus:

P.	W.	F.
calf muscle	body	toes resting on ground and acting as a joint

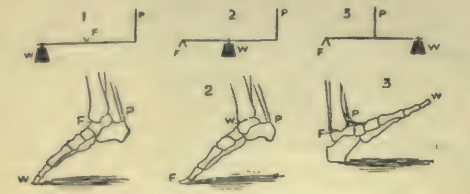
Bending the arm, closing the jaw, are examples of the third order, thus:

W.	P.	F.
hand	biceps	elbow-joint
jaw	jaw muscles	jaw joint

Respecting this third order, observe that the power, or the muscle, is attached between the fulcrum in the joint at one end and the weight to be lifted at the other.

The nearer the muscle is attached to the weight to be lifted the more it has to be contracted to lift the weight, whereas the nearer it is attached to the fulcrum the less it has to contract, but greater force is needed. For instance, consider the attachment of the muscles of the arm and

leg. You will have noticed how all the body-levers have the fulcrum close to the power at the end of the bar. Thus, the elbow-joint is close to the point of the elbow behind, and the ankle is close to the heel; and you will also have noticed in the same way that in every case the muscles are attached as near to the fulcrum, or joint, as possible. Those that lift the arm are fixed just



101. THE THREE ORDERS OF LEVERS

1. Tapping the ground with the foot. 2. Raising the body on the toes. 3. Raising the toes from the ground

below the shoulder [102]; those that lift the forearm are fixed just in front of the elbow; those that move the thigh just below the hip; and those that move the leg just below the knee.

Why a Muscle is Attached near the Fulcrum. The object is to give the greatest movement of the limb with the least contraction of the muscles. If you take two bits of firewood [103] a foot long, and join them together at one end with a tack, open them at right angles, and tie a string from one end to the other, it will be 17 in. long. To bring the ends of the two pieces together by pulling on the string, you must use up all the 17 in.; but if you tie one end of the string close in front of the joint in the way our muscles are fixed, you will find that, though you have to pull harder to bring the pieces of wood together, you only use up about 1 in. in length of the string to move the ends of the firewood 17 in.

By this contrivance, therefore, the slight contraction of the muscles can move the limbs a great distance. When you kick a football, your foot goes through a great space, but the muscle that moves it only contracts an inch or two.

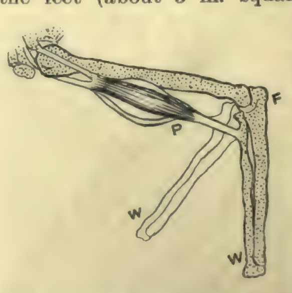
Shoulder and Hip Contrasted. Some special joints in the body call for a brief consideration. Let us first contrast the shoulder and the hip. The shoulder is not a fixed joint, but can be moved backwards and forwards to a certain extent. It is supported behind by the shoulder-blade, and in front by the collar-bone. This latter bone has a double curve; all shocks received at the shoulder, therefore, as in falls, or in striking, etc., are broken by the spring allowed in the shoulder itself, and by the spring in the collar-bone. If the shock, however, is very violent, the jar breaks the collar-bone about the middle. The shoulder is not a universal joint—that is, it cannot move in all directions, but it practically does so, as it is not stopped by the pressure of flesh against flesh in any direction, excepting inwards, when the arm is brought against the side. In an upward direction, however, we cannot raise the arm above the level of the shoulder, because the end of the collar-bone and the arm-bone then come together. If we wish to raise the arm higher, the shoulder itself, being movable, is tilted up. The joint has muscles on all four sides, which pull the arm upwards, downwards, inwards, and outwards.

Now the hip, though a universal, or ball-and-socket joint, differs from this in nearly every particular. While the chief peculiarity of the shoulder is its elasticity and its free mobility, the hip is noted for its great strength and firmness, and limited power of movement.

The hip-joint is perfectly rigid, and never moves itself, the socket being part of the strong bony pelvis. Although the thigh can move in every direction to a slight extent, it cannot move very far in any. Its forward movement, which is the greatest, is checked by the meeting of all the fleshy part of the thigh with the abdomen. Its backward movement beyond a straight line with the pelvis is checked by the strong fibrous band [104] that stretches across the front of the joint. The movement inwards is checked by the other leg, and outwards by other bands, and by a strong cord that fastens the ball of the head of the femur to the bottom of the socket of the hip-bone of the pelvis. It is surrounded with powerful muscles, except on the inner side, where they are weak.

How we Stand Upright. Some other joints may be considered as we look at the phenomenon of the erect position in man. At first sight it appears that nothing could be more natural than the erect attitude. It is only when we look at the means by which it is attained that we see what a feat it is to stand upright. The attitude itself is peculiar to man, and is not natural even to the anthropoid apes.

Let us consider how this position is maintained. We will begin at the foundation and go upwards. This tall column, 6 ft. high, more or less, called the body, is balanced on the front of the feet (about 3 in. square), and upon the two heels (about 2 in. square). The toes are in front of the body, and if the latter tends to fall forwards, press firmly against the ground to prevent it; the heels, too, are behind to prevent the body from falling backwards. If the body tends to fall sideways, the foot on the side towards which it leans, pressing firmly on the ground, restores the balance.



102. DIAGRAM OF ARM-LEVER OF THIRD ORDER

Showing how near the muscle is to fulcrum, and its thickening as forearm is raised

These experiments can be readily tried, and then they will be better understood. In standing on one leg, of course, there is very little to prevent our falling sideways.

Having the two feet, then, firmly planted,

the two legs come next. They are hinged at the knee, and would naturally fold up backwards if not forcibly kept straight. The muscle that does this is the powerful extensor of the leg, which, passing down in front of the thigh, crosses the front of the knee, is fixed into the knee-cap, and continued down to the top of the shin, or the tibia, where it ends, and so braces the leg straight. The leg cannot fold forwards because of the crucial ligament in the knee-joint, neither can it twist to one side or the other.

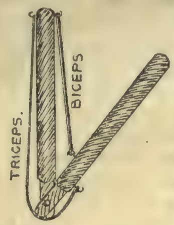
Necessity for Standing Erect. Now we have the two legs upright, how are we to balance the body on the two balls of the hip-joints without falling over?—for it would naturally appear that we should topple forward or backward unless incessantly braced up by muscles before and behind. Here, however, we come across a beautiful contrivance for saving the dreadful fatigue a muscle would undergo by such a continued effort. There is no danger of the hip-joint folding up forwards in the erect position, as the body is heavier behind the joints, and the strain is rather to prevent the body from falling backwards From the front on each side of the pelvis, therefore, passing across the front of each joint, and fixed just below in the front of each femur, is a band of fibres, not muscle, so strong that nothing can break or stretch it. If we stand quite erect the whole strain is thrown off the muscles on to these powerful bands, which, when put to the full stretch, just allow the legs and body to extend in a straight line, but not more; so that the body by this means is balanced on the legs without fatigue. Those who have not learned to stand in this way soon get tired. The spine, being firmly fixed into the hip-bones, is first bent forward, to throw the weight of the heaviest part to the front, and then, as the weight gets lighter, it bends backwards between the shoulders, and forwards again in the neck, there being no joint that can double up between the hip and the neck. At the neck a good deal of the strain of keeping the head erect is taken off by an elastic ligament like a strong indiarubber band, which passes from the occiput to the spine, and so keeps the head erect without effort.

104. ILIO-FEMORAL BAND IN FRONT OF HIP JOINT

Horses which have a long neck, and a heavy head to hold up at the end of it, have a similar band of immense thickness running from the head along under the mane to the shoulder.

The human body, then, tends to fall backwards below, and forwards above; that is, there is less support for it behind at the heels than forwards at the toes; so the ankle, knee, and hip would all fold backwards if they could, while the head would drop forwards on to the chest, as we see it does in sleep, when the muscles are relaxed.

Arrangement to Preserve the Brain from Shock. Before leaving this subject the contrivances to preserve the brain from shock are worth noticing. Passing from above downwards, we notice *first* that the brain itself is saved from all jars by not touching the base of the skull, but floating on a sort of water-bed. The next two provisions are in the spinal column. In the *second* place it is a double curve, forming a double spring, thus breaking shocks; and, *thirdly*, the pad of cartilage inserted between each pair of vertebræ breaks all jars travelling up the bones. *Fourthly*, at the fourth pair the base of the spine is wedged into the pelvic arch. In this case the keystone is inserted between the two side bones, upside down, so that the broadest part of the sacrum looks downwards and forwards, and the narrow end points backwards and upwards. It is thus slung between the bones in such a way, like a carriage hung on "C" springs, that every jar upwards or pressure downwards tends to separate the keystone from the arch instead of jamming the bones together, and so reduce the shock.



103. DIAGRAM OF ELASTIC & WOOD
Showing action of biceps and triceps, and value of the third order of levers

The *fifth* contrivance is that the head of the femur is at right angles to the shaft, which alone reduces the force of shock one half.

The *sixth* is the slant of the femur to the middle line; and the *seventh* is at the knee, where we have between the bones two strong pads of cartilage to prevent all jarring.

The *eighth* is the keystone which forms the instep of the foot. In this case it is set in the usual way, with the broad end uppermost, and the narrow end below resting on a *stout* band of fibres, which breaks all jar.

The *ninth* and last is in the foot, where the hinder pier of the arch comes straight down to the ground, and is formed of one bone, called the heel; but the front pier slopes very gradually, like a spring, and is composed of twenty-four bones. Thus, we get in the foot-arch solidity behind and elasticity in front [6, page 101].

If you stand on a form and jump on to the floor, first on your toes, or the front pier, you will see how beautifully this elastic pier breaks all shock; and then on the heel, you will feel what a jar you get. When we walk, run or jump, therefore, the shock is prevented from reaching the brain:

1. By the water-bed on which the brain rests
2. By the double curve of the spine
3. By the pads between each of the vertebræ
4. By the inverted keystone in the pelvic arch
5. By the neck of the femur
6. By the slant of the thigh-bone

7. By the pads in the knee-joint
8. By the keystone of the foot arch
9. By the spring of the front of the foot

Walking. The movement of the body from place to place is the result of combined action of many muscles. In the act of walking the muscles of the arm should be entirely relaxed, as they are not required in any way, and the arms should be left to hang naturally. Many of the other muscles are used either in maintaining the position of the trunk or in moving the legs.

In starting to walk, say, with the right leg, the muscles of the calf raise the heel from the ground, while the muscles in front of the abdomen pull the body a little forward, still further raising the right heel. When the body is inclined forward to a certain extent, it would fall over were it not for the next act, which consists in allowing the left leg to move forwards to support it. This is done partly by a pendulum-like swing and partly by a forward pull of the muscles in front of the thigh. The left leg is now in front of the body, and the balance is restored; but the right leg has not ceased to act yet. It continues to push the body still further forwards while the muscles in front of the trunk still pull it over, until it is in advance of the left leg, thus raising the right leg off the ground and allowing it to swing forwards in its turn. Walking thus depends on pushing upwards with the leg and pulling forwards with the front of the trunk. As the body is supported alternately on each leg, it is inclined a little from side to side, so as to throw the weight fully on it, and prevent falling over sideways. Thus the body in walking is continually rising and falling, and swaying slightly from side and side.

Jumping, Running, and Hopping. Jumping consists in a spring off the ground, caused by the sudden contraction of both calves forcing the toes so violently against the ground that the body is jerked into the air.

Running is a series of short jumps with each leg alternately, so that both feet are constantly off the ground at the same time. The body is inclined still more forward than in walking, as is seen in soldiers when they change into the "double" from "quick march."

Hopping consists in a jumping on one leg, caused by the most violent contraction of the muscles of the calf of which they are capable.

We may, in conclusion, note that movement is by no means a necessary sign of strength. Babies move all their muscles a great deal, and often without much reason, because their minds have not yet got much control to quiet their movements, but the older and stronger a person gets, the less he moves excepting when he wants to do so, because he has all his muscles under control. To keep constantly moving, therefore, does not show that we are strong, but may indicate that the brain power is weak.

In the locomotor, as in all other systems of the body, there are control centres that prevent unnecessary action, check its being excessive, and tend to promote a steady healthy condition. Such control presides over the action of the heart, the temperature of the body, and the details of the digestion as well as over all muscular effort.

Continued

PNEUMATICS

Air: its Pressure, Weight, and Mechanical Value. Boyle's and Dalton's Laws. Pneumatic Drills, Hammers, and Hoists. Fans and Blowers

continued from page 1695

By JOSEPH G. HORNER

IT is rather surprising that the laws and truths which we intend to consider now were unknown until within comparatively recent times. Three hundred odd years before the time of Christ, Aristotle brought his great mind to bear on the subject, but came to the alarming conclusion that air had no weight. Thenceforward, for close on nineteen hundred years, things were seen as through a glass darkly. The eagerness with which gases and liquids rushed in to fill a vacuum was glibly "explained" by the phrase, "Nature abhors a vacuum." In the seventeenth century that galaxy of great minds—Galileo, Guericke, Torricelli, and Pascal wrested from Nature the great truths that underlie the questions of pressure and elasticity of gases.

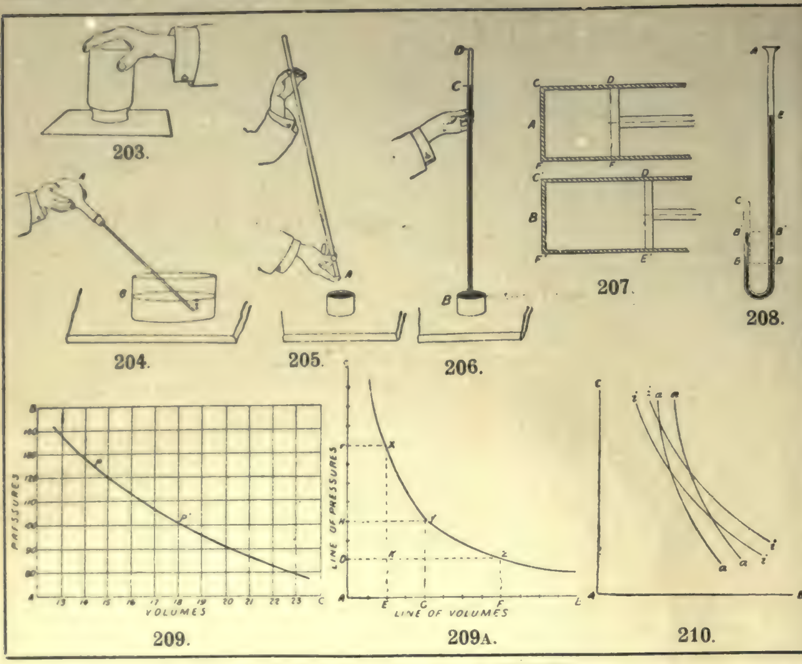
The pressure and elasticity of air (which may be taken as a typical gas) may be clearly and visibly demonstrated by simple experiments which can be easily performed by the student. If, for example, a tumbler or beaker be entirely filled with water, and a sheet of paper pressed over the mouth and the tumbler inverted as in **203**, the paper remains in position, and the water in the glass. One might think that both paper and water would fall to the ground immediately the glass were inverted. This does not happen because, great though the pressure of the water may be, the pressure of the atmosphere against the paper is still greater. If, however, the vessel be not completely filled—that is, if air be present inside, the exterior pressure is neutralised and overcome.

Expansibility of Air. The expansibility as well as the pressure of the atmosphere is illustrated in **204**. The empty flask A is fitted with a cork, through which a long piece of glass tubing passes. The end of the tube is placed beneath the surface of the water in the trough B. (If the water be coloured with a little red or black ink its movement will be more readily seen.) The two hands are then placed round the flask, as shown in the illustration, and the heat they impart to the air contained in the flask causes it to expand and escape, as will be seen by the stream of bubbles which rise through the water. When the hands are removed, and the flask and its contained air resume the ordinary temperature, water will rise from the trough and up the tubing towards the flask. The liquid rises against the force of gravity because the pressure of the atmosphere acts on the water surface, is transmitted upwards through the tubing, and so causes the liquid to fill the space which was occupied by the expelled air. If the flask were gently heated with a Bunsen flame, the results would, of course, be still more pronounced.

The Schoolboy's Sucker. The schoolboy's sucker is another and a striking illustration of air pressure. A piece of leather attached to a string is well soaked, and then pressed firmly with the foot against a smooth surface, so as to exclude all air between the leather and the surface. It is then found difficult or even impossible to pull the leather away from it; if the leather be in contact with a slate or a loose slab of marble these things may be easily lifted into the air. This is not due to any "suction," but to the great pressure of the atmosphere outside the leather, and the absence of any air between the sucker and the substance to which it holds.

Measuring Air Pressure. The experiments just described prove that the atmosphere has weight, but give us no idea of its amount. A means of measuring that weight is shown in an experiment first performed by Galileo's pupil Torricelli, and since repeated millions of times in the schools, colleges, and laboratories of the world. A pump had been sunk at Florence, but the water obstinately refused to rise above 33 ft. Galileo was consulted, and he concluded that the air had weight, and that a column of water 33 ft. in height was as much as the weight of the atmosphere could balance. Afterwards his disciple Torricelli studied the question. Taking a glass tube about 3 ft. long and closed at one end, he filled it with mercury. The tube was inverted, the open end being temporarily closed with the finger [**205** A], and placed below the surface of mercury in a vessel (B) [**206**]. Immediately the mercury in the tube dropped to a height of 30 in. above the level of the mercury in the vessel. A vacuum (called the Torricellian vacuum) was produced (CD). The only possible conclusion was that this 30-in. column of mercury was balanced by the atmospheric pressure. This was verified by Pascal, who repeated the experiment on the summit of the Puy de Dome, in Auvergne. Two tubes were filled with mercury, and at the foot of the mountain the liquid stood at 28 in. in both tubes. One of them was then taken to the top of the mountain. As they ascended the observers found that the mercury fell to 24·7 in., and as they descended it rose again to 28 in. Pascal's expectations were fulfilled, for he had reasoned that as the pressure of the atmosphere on a mountain-top was less than on the earth's surface, it would only support a correspondingly shorter column of mercury. And as this proved to be the case, it was clear that the mercury was really supported by the weight of the atmosphere.

A cubic inch of mercury weighs ·49 lb., and $30 \times {\cdot}49 = 14{\cdot}7$ lb. Therefore, as the atmosphere supports a column of mercury whose weight is **14·7** lb., and whose base measures a



ILLUSTRATIONS OF AIR PRESSURE

varies inversely as the pressure, temperature remaining unaltered. Thus, if at a pressure P the volume of a given quantity of a gas be V, and the volume changes to V′ at a pressure P′, then P : P′ : : V′ : V. The product of the extremes being equal to that of the means, PV = P′V′, or $\frac{P}{P'} = \frac{V'}{V}$.

If in **207** A and B represent the same cylinder with the piston in the two positions shown, then the pressure when the piston is at DE is to the pressure when at D′E′, as the space C′D′E′F′ is to the space CDEF. The reader will now see how highly important this law is in engineering, for, translated into technical parlance, it tells us that in the steam in an engine cylinder, the gas in a gas-engine, and the air in an air-engine, as long as temperature is unchanged, the pressure, or elastic force, varies inversely as the volume occupied by the gas.

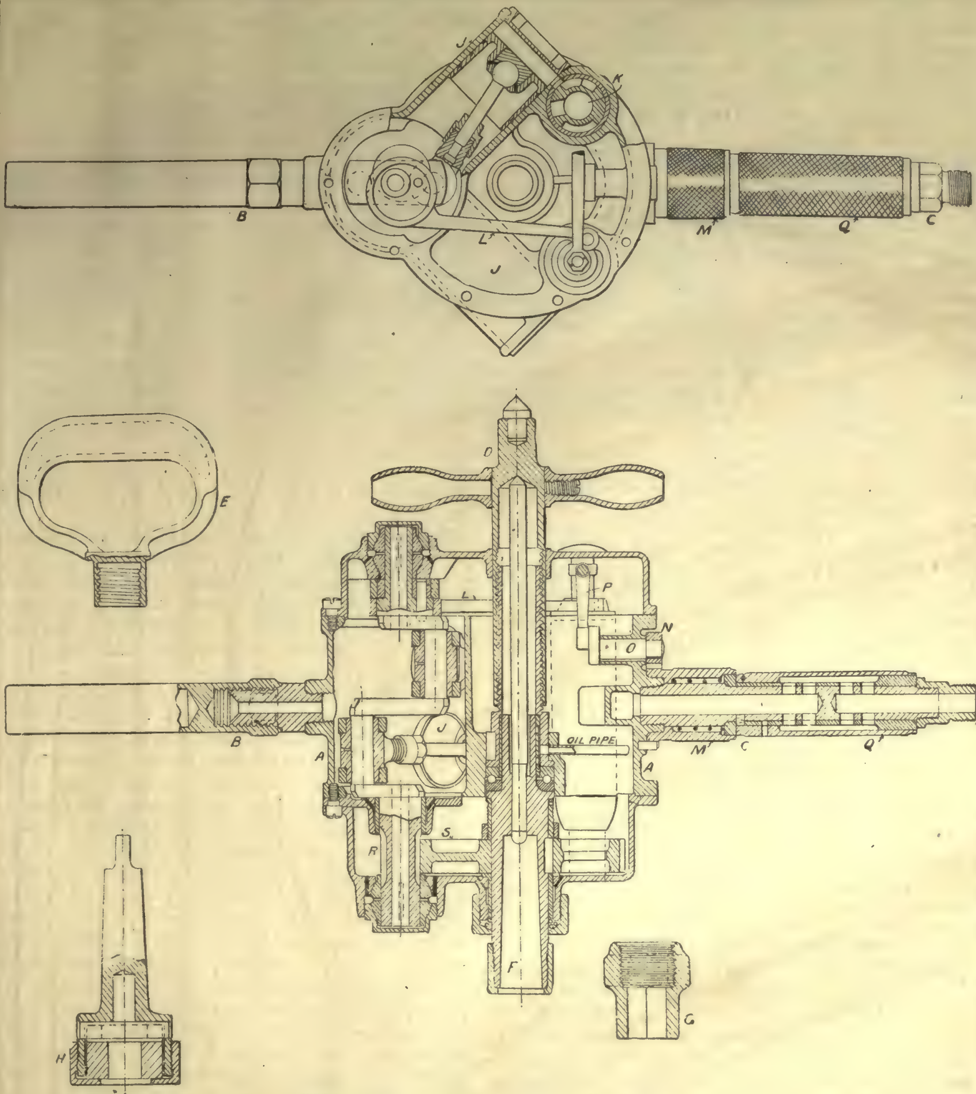
square inch, we are driven to the conclusion that the pressure of the atmosphere amounts to 14·7 lb. on every square inch. And this pressure, as in the case of water, acts equally in all directions. Mercury being 13·6 times heavier than water, the atmosphere would support a column of water equal in height to 30 × 13·6 in., or $\frac{30 \times 13{\cdot}6}{12}$ ft. = 34 ft. This explains why water refuses to rise to a greater height than this (in practice not more than 25 ft.) in a common lift-pump; hence also the need of a liquid of high specific gravity for use in a barometer.

To this pressure of the atmosphere, then, we are indebted not only for the action of the barometer but also for the action of the various types of water-pumps [see page 1080]. It has, however, been thought fit to deal with pumps under HYDROSTATICS, for the reasons stated in that lesson.

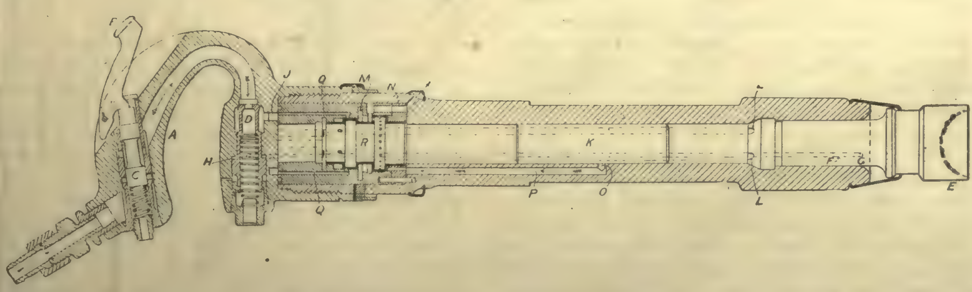
Boyle's Great Discovery. Mention has been made in the course on IDEAS of remarkable cases of simultaneity in discovery. An example of this occurs in the subject now under consideration. In the latter half of the seventeenth century, Robert Boyle, in England, and Edme Mariotte, in France, were both studying the effect of pressure applied to a gas. Their investigations led each to arrive independently at the same great truth, and so nearly simultaneous was the discovery of the law, that in England it is known as Boyle's Law, on the Continent as Mariotte's Law, and sometimes as Boyle and Mariotte's Law. There seems, however, no doubt that the great English, or rather Irish, physicist was first. Boyle's Law may be stated: *The volume of a gas*

Verification of Boyle's Law. The law may be verified by means of a long bent tube, as in **208**. Mercury is poured in at A (or at C, and this opening then closed) until it stands at the same level B—B in both branches. Then the air in the closed portion (BC) is at the pressure of the atmosphere. By pouring more mercury into the tube at A, the air in BC gradually becomes more and more compressed, owing to the increased pressure in the long branch. Both the decreasing volume of the air and the increasing pressure of mercury producing it may be measured, and the results tabulated. In a uniform tube such as this the volume is proportional to height, so that a finely-divided scale is all that is necessary for measuring volume and pressure. For the total pressure in each case, the height of the mercury in the long branch above the level of that in the short one must be added to the pressure of the atmosphere, as indicated by the barometer at this particular time, for the pressure of the air in BC is evidently equal to the sum of these two. If for example the air be compressed to occupy the space B′C the height B′E would be added to the barometer height.

The table given shows a series of readings so taken. The first column gives the level



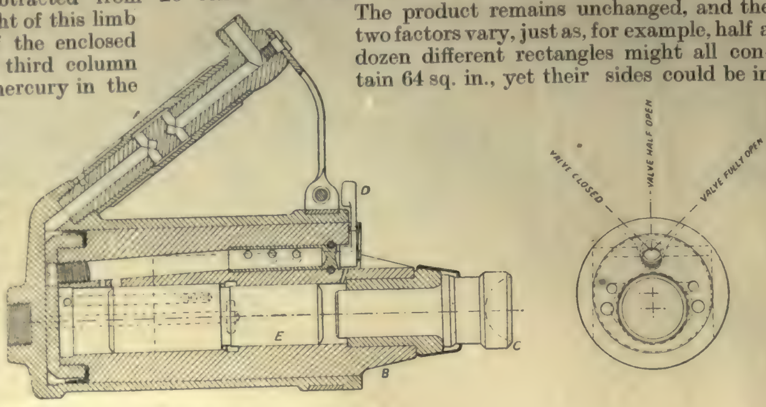
211. DETAILS OF PNEUMATIC DRILL



212. SECTION OF PNEUMATIC RIVETER

REPRESENTATIVE PNEUMATIC TOOLS

(in centimetres) of the mercury in the short branch, and this, subtracted from 26 centimetres—the total height of this limb—gives the height of the enclosed column of air. The third column shows the height of mercury in the long limb, and the difference between this and the level in the short one gives the pressure stated in column four. But the enclosed air is subjected not only to this pressure, but also to the additional pressure of the atmosphere, in this case 76·57 centimetres. Thus the total pressure is that in the fifth column.



213. THE "HOLDER-ON"

Air.		Mercury.			
Level of mercury A	Height of air in short limb, 26 cms. − A = V	Height of mercury C	Difference in level of mercury, C − A = D	Total pressure, 76·57 + D = P	Constant, V × P = K
2·2	23·8	2·2	—	76·57	1822
2·8	23·2	4·75	1·95	78·52	1822
3·2	22·8	6·4	3·2	79·77	1819
4·15	21·85	10·75	6·6	83·17	1817
5·55	20·45	17·75	12·2	88·77	1815
6·95	19·05	25·7	18·75	95·32	1816
8·0	18·0	32·4	24·4	100·97	1817
9·9	16·1	46·0	36·1	112·67	1814
11·6	14·4	60·7	49·1	125·67	1810
12·6	13·4	71·2	58·6	135·17	1811
				Average	1816

Pressure and Volume. On comparing the tabulated results the truth of the law will be evident. A glance shows that as the pressure (P) increases, the volume (V) decreases, and the ratio in which this occurs is seen by taking any two pressures and corresponding volumes. Thus the pressure 125·67 is roughly one and a half, or $\frac{3}{2}$ times 83·17. But the volume corresponding with the first-named pressure is approximately $\frac{2}{3}$ of that at the second pressure. Similarly, with more extended investigations it would be found that with twice the pressure the volume is halved; with 3, 9, 12, 50, or n times the pressure, the volume is reduced to $\frac{1}{3}, \frac{1}{9}, \frac{1}{12}, \frac{1}{50}$, or $\frac{1}{n}$ of the original volume. Moreover, the number (K), obtained by multiplying together the volume and the pressure in each case varies but little from the same product in the other lines. This slight variation is explained by trifling errors of experiment. This fixed value of V × P enables us to state the law thus: *Temperature being constant, the product of the pressure and volume of a gas is a constant.* If one be known, the other is easily found by reducing the law to the formula: *Pressure × volume = constant.* The product remains unchanged, and the two factors vary, just as, for example, half a dozen different rectangles might all contain 64 sq. in., yet their sides could be in inches: 64 × 1, 32 × 2, 16 × 4, 8 × 8, 12·8 × 5, 6·4 × 10.

Investigations with pressures less than that of the atmosphere also verify the law.

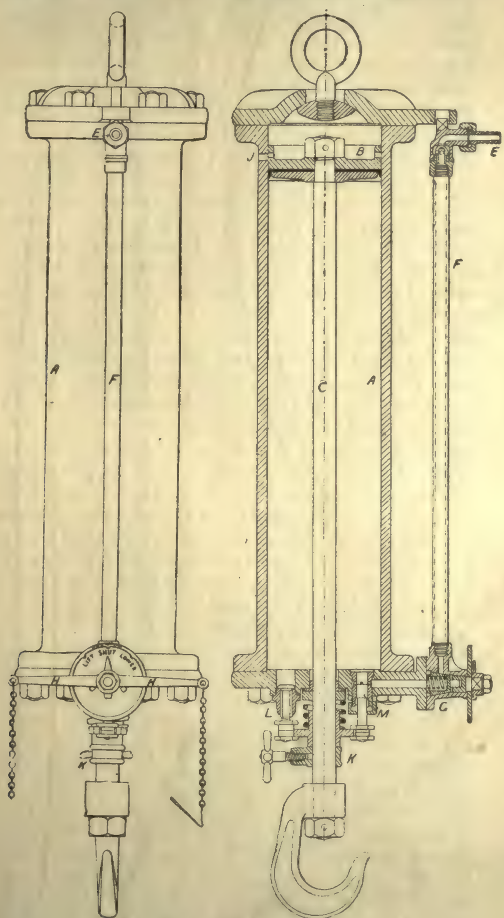
Behaviour of a Gas. The story of the behaviour of a gas under varying pressures may be told in a more attractive manner by means of graphic representation. The pressures and volumes in the table may be plotted as in 209, where the bottom (AC) is figured for horizontal line volumes, and the vertical line (AB) for pressures. Then the story is told by the curve. As it extends in the direction C—that is, as the volume increases, the curve sweeps downwards—in other words, the pressure falls; or, as the curve rises the volume decreases and pressure increases. At the point P the volume is about 14, and the pressure 125 centimetres; at the point P′ the volume is 18, and the pressure 100 centimetres. With a wide range of pressures and volumes [209A], it will be seen that the curve, though it approaches nearer and nearer to the lines of volumes and pressures, never touches either. The reason for this is clear when we consider that no increase of pressure can bring the volume to zero, and no increase of volume can reduce the pressure of a gas to the vanishing point. It would thus be impossible for this line to be straight, for then it would eventually cut both the line of volumes and of pressures.

Curve of Volume and Pressure. Since the product of the volume and pressure of a gas is constant, this curve exhibits another useful property. If we take any three points, as X, Y, Z [209A], then at X the pressure is represented by XE, and the volume XI; at Y, pressure = YG, and volume = YH; at Z, pressure = ZF, and volume = ZD. Therefore, the areas XIAE, YHAG, ZDAF, are all equal; and this would be the case with a point taken at any position on the curve. Because of this property the curve is known as a rectangular hyperbola. Thus the position of any point indicates the two factors volume and pressure, and if one be known the other is immediately found. For

if we are given a volume which, according to the scale adopted, equals AF, then by laying this distance along the line of volumes AB, and erecting a perpendicular at F, the pressure is seen to be equal to FZ, or, by referring to the scale chosen, AD.

Referring again to the diagram, if Z marks the first and X the final condition of the gas, then the actual diminution in volume is represented by ZK, and the increase of pressure by KX. The work done by the pressure in changing the volume from AF to AE is represented by the area of the figure ZXEF.

The Law of Dalton. When two or more gases of different kinds are mixed together—and this sometimes occurs, as in the case of air and water vapour in the air-pump of a condensing engine—*the total pressure exerted by the mixture is equal to the sum of the pressures exerted by the different gases.* In other words, each gas exerts



214. AIR HOIST

its own pressure just as though no other gas were present. This is, in reality, a general law, of which Boyle's Law is a particular case—a fact which will be readily seen on comparing the statement above with that of Boyle's Law as simplified by Professor Rankine: "If we take a closed and exhausted vessel, and introduce into it one grain of air, this air will, as we know, exert a certain pressure on every square inch of the surface of the vessel. If we now introduce a second grain of air, then this second grain will exert exactly the same pressure on the sides of the vessel that it would have exerted if the first grain had not been there before it, so that the pressure will now be doubled. Hence we may state, as the property of a perfect gas, that any portion of it exerts the same pressure against the sides of a vessel as if the other portions had not been there."

The Question of Temperature. The general effect of heat on solids, liquids, and gases is to cause expansion, and, as a rule, gases expand more than liquids, and liquids more than solids. And it is a well-known fact—a matter of common observation—that if equal increments of temperature be applied to a number of solids (say, rods of copper, iron, zinc), or to a number of liquids (water, alcohol, mercury), there is a considerable difference between their relative expansion, whereas with all gases and vapours expansion proceeds at the same rate when heated through the same interval of temperature. Thus the second great law of gases runs: *The volume of a gas under constant pressure expands, when heated, by the same fraction of itself,* whatever be the nature of the gas (the Law of Charles). What is this fraction?

Experiment has shown that 1,000 volumes of air at 0° C. become 1,366·5 volumes at 100°—*i.e.*, 1 volume at 0° increases to 1·003665 at 1°. The amount of increase in volume for 1°, ·003665, approximately equals $\frac{1}{273}$, and so this fraction is called the coefficient of expansion for air. Thus, for every increase of 1° C., the volume of the gas is increased $\frac{1}{273}$ of its volume. Therefore, 1 cub. in. of a gas at 0° C., when raised to

$$1^\circ = 1 + \frac{1}{273} \text{ cub. in.}$$

$$2^\circ = 1 + \frac{2}{273} \quad \text{,,} \quad \text{,,}$$

$$30^\circ = 1 + \frac{30}{273} \quad \text{,,} \quad \text{,,}$$

$$n^\circ = 1 + \frac{n}{273} \quad \text{,,} \quad \text{,,}$$

Therefore, 273 volumes at 0° are changed to 274 volumes at 1°, 275 volumes at 2°, and so on.

Volume Reduced by Lower Temperature. Now, as a gas expands uniformly with uniform increments of temperature, it follows that with uniform *reduction* of temperature the gas should decrease in volume by uniform fractions of itself—that is, for every degree through which the gas is cooled below 0° C., it should lose $\frac{1}{273}$ of its volume. Then it follows that if cooled through 273 degrees below zero, the gas would theoretically occupy no volume whatever. Such a temperature has never yet been reached, but it is pretty certain that a gas would cease to exist as such at this low temperature. This theoretical point, − 273° C., is therefore called the absolute zero of temperature, and when reference is made

to "absolute temperature" it means that the temperature is reckoned from this absolute zero. Absolute temperatures are obtained by adding 273° to the C. reading. If it be the temperature on the C. scale, then absolute temperature = t + 273°. This conception of absolute temperature enables us to connect the two great laws which govern the behaviour of gases: *In a gas the volume (at constant pressure) or the pressure (at constant volume), is proportional to the absolute temperature.* Or, the product of the pressure and volume is proportional to the absolute temperature. If V equals the volume of a gas; P the pressure; and T the absolute temperature, then the ratio $\frac{VP}{T}$ is constant for that gas for all values of V, P, and T.

Practical Importance of Temperature. In making the observations on which the table verifying Boyle's Law was constructed, and from which the curve in **209** was plotted, pressure and volume only were considered, temperature remaining constant. But as far as engineering is concerned, temperature *does* invariably enter into the question, so that when we come to consider the behaviour of steam in the engine cylinder, or air in an air compressor, for example, the problem becomes more complicated. When a gas suffers compression, heat is produced, and unless the pressure is gradual and long continued, the heat produced will be unable to pass away by conduction. It is then evident that the curve traced to show the relations between pressure and volume *when temperature is constant* will not coincide with the curve produced when the heat caused by compression is not allowed to escape. For any gas a number of curves may be traced, each at a different but constant temperature, and these are called *isothermal* lines (Gr. *isos*, equal; *thermē*, heat). So far, we have considered only changes in volume and pressure which have taken place isothermally, and the curves in **209** and **209A** are isothermal curves.

When, however, a gas is compressed, and expands under conditions which prevent any heat passing in or out of the chamber containing it, its behaviour would be represented by a line which would pass from one isotherm to another. Such lines are called *adiabatic* (Gr. *a*, privative prefix; *dia*, through; *baino*, I go). In **210** *i*, *i* are isothermal lines, *a*, *a* are adiabatic lines. The most striking feature about these curves, as compared with the isothermal lines, is the relatively greater angle which they make with the horizontal line AB. This means that a much greater increase of pressure is necessary to diminish the volume of a gas when under adiabatic conditions than when acting isothermally; for a definite increase in pressure the volume will be greater when no heat enters or escapes than when the case is otherwise—a fact which is shown by the diagram.

Compressed Air. Though free air—that is, at atmospheric pressure—is utilised by engineers, air when compressed also becomes a motive power of very great value. Its applications have grown enormously in recent years. To name only a few, miners' rock-drills are actuated thus; mine locomotives and coal cutters also are driven by air. Sunken vessels are raised; hammering, chipping, caulking, riveting, tapping, etc., are effected; parcels are transmitted through tubes, and loads are lifted by cranes.

When air is compressed this is done by the movement of a piston in a cylinder, the average amount of pressure for ordinary purposes being usually 60 to 80 lb. per square inch. When higher ones are required, the work is done in two or three stages, and for some purposes pressures of 500 lb. and more are employed. When air is compressed thus, and made to do work, it does so by virtue of its expansion, by which a portion of the power expended in compression is returned; for convenience, it is stored in a receiver, resembling a steam boiler externally, either vertical or horizontal. There are considerable losses due to friction and the generation of heat, so that an efficiency ranging only from about 30 to 60 per cent. in different cases is available. The use of compressed air has given rise to an immense number of machines, both for its generation and utilisation. With the first we cannot deal here, and a few selections only from the second can be offered.

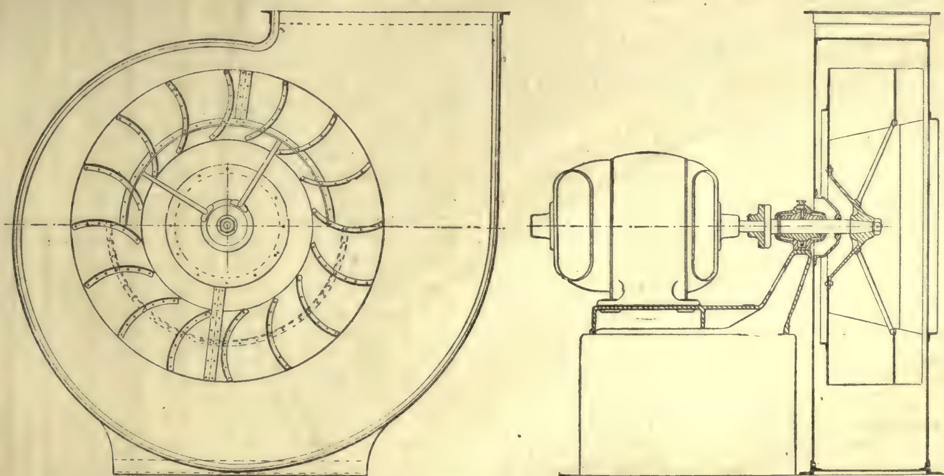
Pneumatic Drill. The production of rotary motion by means of compressed air is most economically effected by using cylinders and cranks, as in steam-driven reciprocating engines. An example of a pneumatic drill is shown in **211**, used for boring holes in wood and metal, as well as for reaming and tapping, etc. The main body, or casing (A), has two handles (BC), screwed in, providing a means for holding the machine steadily, and also of controlling its action. The counter-pressure is taken by the point centre at the top, fitted in a screw-sleeve (D), which is employed for feeding the drill into its work as cutting proceeds, D being revolved slightly at intervals to force the entire casing downwards, using the hollow handle seen near the top for turning D. Alternatively, a grip-handle (E) (shown detached) is used, where the work permits, such as when wood boring, tapping screw-holes, etc. The tools are held in the taper hole of the spindle F, and can be forced out by screwing down the handle and sleeve D, which action pushes the internal ejector-rod down upon the drill. For square-shank drills another socket (G) is provided, and another (H) for tapping.

The driving mechanism comprises four single-acting cylinders (J), arranged in pairs at right angles to each other, having the pistons connected with rods to a crank shaft, the pins of which stand at 180° to each other, forming a balanced set. Each pair of pistons is controlled by a balanced "Corliss" valve K (seen in plan) actuated by eccentric rods (L). The valves K are made with a duplex set of ports, so that, by raising or lowering them, the action of the drill can be reversed. The motion is effected by rotation of the knurled sleeve M on the handle C, turning a small pinion on the crankshaft O, this raising or lowering a connecting rod P, fitted with cross-arms, bolted to the ends of the valves K. The handle C has also a throttle mechanism, to

turn the air supply on or off, the sleeve Q being rotated to allow the series of holes seen to communicate with each other when starting, so that the air passes from the flexible hose attached to the end of C, right throught the handle, and by passages into the valves and cylinders. The drive from the double-throw crank-shaft to the spindle is seen to be through spur-gears R and S. Oiling is effected by removing the handle B, and also through the pipe seen leading to the spindle, whence the lubricant then spreads to all parts of the mechanism. These tools can be used by divers under water when necessary.

Pneumatic Riveting. The application of compressed air to riveting is shown by the sectional drawing of a "Boyer" long-stroke hammer [212], which is held in the operator's hand, and supplied by a flexible pipe, led through the coupling at the base of handle A. On pressing the thumb-trigger B, the valve C allows the air to pass through the hollow chamber in the hand into the automatic valve D, whence, if the into chamber M, allow the air to get along the holes LL, in front of the piston, to drive the latter back. The remaining air at the back of the piston rushes through the ring of holes (shown black) in the valve R, the latter being then in its backward position, so that the holes exhaust into N. The return stroke continues until the piston blocks the (black) holes in R, and the little remaining air is forced back (forming a cushion device, meanwhile) into other orifices at the rear portion of R, communicating with a shoulder on the latter, and causing the air to move R forward ready for another stroke. Other types of these tools are constructed for chipping and caulking, the action being similar, proportions varying, however, to suit the work.

The "Holder-on." An appliance used in conjunction with the riveting hammer is the "holder-on" [213], used on the head of the rivet which is being closed instead of the usual "dolly." The tool is brought up to the work, a bar being screwed into the back end for support, and the



215. VENTILATING FAN AS USED IN THE LONDON UNDERGROUND ELECTRIC RAILWAYS

snap E at the extreme end is not pressed on the work, escape occurs through the passage F and hole G. This constitutes a safety device to prevent danger to the workman through the snap being driven violently against the rivet from a distance.

But, on commencing to rivet, the pressure on E forces it backwards, so closing the orifice G. The air in D then presses on the annular shoulder at H, forcing down the valve D, and allowing air to get past the coned seating at the top into passage J, when it gets to the rear of the piston and drives the latter forward against the snap end. The air at atmospheric pressure in front of K has to be got rid of, and this is effected by providing orifices LL, leading through passages (seen dotted) back into the annular chamber recess M, communicating with the atmosphere by channel N. The return of the piston K is accomplished thus: As its rear end passes the port O the air escapes into P, and thence reaches the "constant pressure" ports Q, which, leading throttle formed by the revolvable hand-grip A opened, thus forcing the large cylinder B outwards, and pressing the snap C on the rivet head. The valve D is then opened, causing the piston E to reciprocate, and beat the rivet well into its hole, at the same time the riveting hammerman, on the other side of the plate, begins to turn over the tail. The holder-on valve is then shut off, stopping the piston E, but still keeping the snap pressed up; the elasticity of the air behind the cylinder B forms a cushion or spring, which allows the tool to yield slightly at each riveting blow. When closing is finished, the throttle A is opened to exhaust, and the holder-on removed. The air-passages are seen in full and in dotted lines in sectional and end views. These tools are from the practice of the Consolidated Pneumatic Tool Co., Ltd., of London.

Air Hoist. Hoisting is done either by the application of cylinders imparting a rotary motion (the mechanism being very similar to

that in 211) to a drum, upon which the lifting chain or rope is wound, or by direct action, as in the hoist [214] (Alley and Maclellan, Ltd.). Here a long cylinder (A) carries a piston (B) and rod (C) to the bottom end of which the hook is attached. Air is admitted from a hose through the pipe at E, passing into the vertical pipe F through a check-valve, which instantly closes should the supply fail, retaining the air already in, and so keeping the load from dropping.

Admission to the cylinder at the bottom is controlled by the throttle G, opened and closed by the levers H H, moved by hanging chains in either direction. As the piston B rises, the air above it escapes through the orifice J, but when near the top of the stroke this is closed by the piston, the little air left forming a cushion, which prevents the piston banging against the cylinder head. An automatic balancing device is fitted to the bottom cover, so that a load may be kept suspended at a uniform height for a while, even though its weight varies, which is the case in building up a mechanism, or emptying a ladle of molten metal. A ring (K) is clamped to the rod C at any desired position, so that, should the load lighten, and the piston consequently rise a little, K opens an escape valve at L, allowing some air to pass out; if, on the other hand, the weight hangs for a long time and air gradually leaks out, a valve at M opens and admits sufficient to compensate for the loss. The eyebolt at the top of the cylinder is suspended from any suitable anchorage, either a beam, or a trolley running upon girders, or a crane-jib. Hoists of this type are made in other patterns, usually of longer stroke than the example shown, and also placed horizontally, operating lifting ropes, passing over pulleys to the ground.

Fans and Blowers. In our study of hydraulics mention was made of the centrifugal pump. There is a machine which differs in no essentials from this pump, which is utilised for the discharge of air, and is termed, according to its method of operation, a *fan*, or a *blower*.

Free air is drawn in at the sides of the fan by the creation of an induced draught, produced by the revolution of the fan, from any source of power. It is then discharged at the outlet, just as the water is discharged from the centrifugal pump, at a rate and pressure depending on the size of the fan and its number of revolutions. It is obvious, therefore, that this machine can be used to exhaust air by drawing it through the vanes, or to force it under pressure into pipes connected with the outlet; and the two may be used in combination—that is, induced and pressure operations combined.

Fans are used for a large number of purposes, the chief of which are the ventilation of mines, public buildings, and factories. In connection with the last two a growing practice is to connect the fans with apparatus for heating the air in winter, and by a system of pipes to discharge it at intervals throughout the building. This is more satisfactory than utilising the natural draught from open windows. Both methods are employed, the induced draught and the pressure system, termed respectively the iteus and the item, concerning the merits of which much controversy has arisen. Another purpose for which the fan is used is in supplying blast to the cupola furnaces of iron-founders and to smiths' forges. The only rival to the fan is the pressure-blower of the Root's and similar types, illustrated in the last article. The fan is a rival to the tall chimney for creating draught in the furnaces of steam boilers; its expense is much less, and it is generally capable of better regulation.

There are three methods of employing fans in connection with steam boilers. Induced draught fans may be used in the main flues of one or more boilers, where of course the fan deals with the gases at a very high temperature. On the other hand, fans are installed to deliver the air at normal temperature directly into a closed ashpit, or closed stokehole, with or without passing through an auxiliary heater, heated by the waste gases from the furnaces. In marine work the practical impossibility of having high chimneys makes it absolutely necessary to employ forced draught, which is most satisfactorily and economically obtained by means of centrifugal fans.

Science of Fans. The mathematics of the fan are rather troublesome, and actual experiment, as in centrifugal pumps, is the only safe basis on which to guarantee results. The subject is too wide for discussion here. The principal factors are the size of the fan and the speed at which it is driven. The volume of air delivered practically varies directly with the speed; the air pressure generated varies as the square of the number of revolutions, and the horse-power required to drive varies as the cube of the velocity. Doubling the speed of a fan, therefore, doubles the volume of air delivered, and increases the pressure produced by four times that originally existing, while the power required is eight times greater. But, in selecting a fan, more than this is required because of the great losses due to friction, leakages, and the effects of bends, long pipes, and, when the air is heated, losses due to resistance of the heater-pipes. A safe rule is to select a large rather than a small fan, one with ample capacity running at moderate speed rather than a smaller one running at high speed. Like many other matters connected with engineering, it is one in which expert advice should be sought.

Fig. 215 is a good example of a ventilating fan, of which thirty-nine were supplied to the Underground Electric Railways Co., Ltd., of London, by Messrs. Heenan and Froude, Ltd., of Worcester. The vanes, or blades, mounted on the 5 ft. 6 in. revolver, are of $\frac{1}{8}$th in. steel plate, riveted to the $\frac{3}{16}$th in. and $\frac{1}{8}$th in. circular plates. The body of the fan is also made of $\frac{1}{8}$th in. plate, combining lightness with a strength sufficient for the purpose. The drive is by electric motor, as seen to the left.

Continued

ORGANISED TRAVEL

Continued from page 1650

Organisation of Travel Parties. Duties of the Leader. Special Tourist Reductions in Fares. Cost of a Typical Tour. Necessary Baggage

By Rev. A. L. FILLINGHAM

It is becoming common for a few friends to co-operate in a holiday arrangement, especially for Continental excursions. The vast possibilities that lie behind this kind of enterprise are scarcely realised. In all such cases it is essential that one, or two at the most, should arrange for the whole excursion.

The Leader of the Party. The supreme difficulty is in securing the right leader. A lady or gentleman of very even temper must be found, who can at the same time be very firm. Combined with a fund of patience there must be some amount of liveliness and good spirits if the party is to go its way with the constant pleasure they naturally desire. There must also be a very clear head for business and some acquaintance with the foreign languages that may be encountered. When the right leader has been found, the very first thing to determine, either mutually or by the leader's choice, is the country that is to be visited, and then more particularly the route by which it will be reached and the district that will be traversed. It will also be necessary to determine whether completely independent arrangements shall be made or whether some of the facilities offered by touring agencies shall be utilised. For instance, it may often serve the purpose of a party to take one of the very cheap week's arrangements offered by nearly all touring agencies, and then continue in the country paddling their own canoe. If they agree to take the whole of the tour under the control of an agency, they will find that a reduction of about 10 per cent. will be granted for a party that includes a reasonably large number.

The scope of this article, however, is specially to explain how a party of this kind can be arranged as a private company which intends to make all its own arrangements under a conductor of its own selection. In making details clear it will be well to treat first of those things which must be done before leaving home, then of those things which will need attention on the holiday itself, and, finally, to give a few samples of cost, etc.

Before Starting. Letters should be sent to the railway or steamboat companies that are most likely to offer travelling facilities to the country that has been selected. The lowest rate for the smallest party, that would be counted as a party, must be ascertained. It will generally be found that substantial reductions of about 30 per cent. can be secured for a party of at least 30 travelling together on the outward journey, but having the right in most cases to return home independently. It is no use wasting correspondence as to independent travel on the outward journey or a smaller minimum than the one which will be stated by the company granting any concessions. These conditions are essential and fixed.

It will be desirable to get the best guide-book to the country selected, and the most modern edition, and to trace out a reasonable itinerary. If a large number in the party are going to the country for the first time they will naturally—though foolishly—desire to see as many places as possible. If that desire can be restrained, or if a large number in the party have been to the country previously, it will be desirable to limit the number of stopping-places to one per week. In any case, if a place is worth visiting at all it is worth at least three or four days. If shorter stays than this are made, the labour of packing and unpacking becomes tedious to the party and the process of settling and unsettling his company becomes very trying to the conductor. In a four-night stay three days are secured in which the more vigorous may explore the vicinity more or less widely.

Preliminary Correspondence. Having fixed upon the places to be visited and the time to be spent at each one, it will be desirable to communicate with the foreign railway companies or their agents in England—*e.g.*, Swiss Federal Railway Office, Shaftesbury Avenue, London, W.C.—and find what is the cheapest "rundreise" ticket inside the country which would cover the tour projected. In Belgium, Switzerland, and a few of the more frequented countries very special tickets are often issued which will cover *all* the railways on the national system. In Switzerland a ticket for 15 days bearing the photograph of the person to whom it is issued, to prevent double use, can be procured for about 30s., and is valid on all the ordinary railways and steamboats of the country. When there is a desire to see many things instead of much, these tickets are great economy. When one is staying near a railway line or steamboat course it may save money and provide much enjoyment to have such a ticket in daily use, even though it is not taken outside the district.

Hotel Arrangements. The return "party" fare to the country and the probable railway expenses in the country having been thus ascertained, it is necessary to select from the guide-book two or three likely hotels in each centre where the party proposes to settle. A penny postcard to the respective proprietors will soon bring in quotations for rooms, light, and attendance, breakfast, and evening dinner, if the probable date of the visit, length of stay, and number of persons in the party is stated on the inquiry.

We append a form of postcard inquiry which is found to answer the purpose well:

DEAR SIR,

We hope to bring a party of........persons to................on..........for....days. Will you please send by RETURN POST your price per person per day for hotel accommodation. We should require about two rooms for every three persons, light and attendance; café complet (lunch ?) and table d'hôte; also free carriage for hand baggage to and from station; all included. Please say what you would charge per person each way for those who use the 'bus to and from station. Also please state what you would deduct from pension terms when notice is given before 9 a.m. that déjeuner will NOT be required ?

If you could kindly send a map showing where your hotel is placed and a picture of the hotel itself, these will help me to decide.

If you can name any other English party that has stayed with you—giving name and address of conductor—it would oblige. We will reply to your offer a week (or month) before arrival if it is accepted.

As lunch is usually a difficult meal to arrange beforehand when sight-seeing, it is well to make special mention of this, and to ask for terms "with and without luncheon."

The Programme. When all these financial points have been approximately settled, it will be necessary to draw up a programme to submit to all the friends likely to join such a company. This programme should give the station and time for meeting in London, with the exact date; the route chosen and length of sea passage; the condition of united travel on the outward journey; the places to be visited, and, if already settled, the names of hotels; the cost of tour, preferably including a due allowance for extras, or with extras clearly stated; the class of travel at different points should be indicated, the cost of excursions if not included in the main booking; the number of days that the ticket is valid for independent return; the number of days' hotel accommodation included in the cost specified; the possible personal extras such as midday meals, refreshments on the journey, carriage drives, gratuities, and anything that may come in over and above the general cost specified.

If the response to this programme from one's own friends is not sufficient to secure the minimum number required, it will generally be easy to secure likely inquirers by advertising in newspapers that commend themselves to the promoter.

We imagine now that all preliminary arrangements are made and the required minimum have definitely booked. We may add also the hope that they have paid a goodly portion of the money at least a few days before starting. This saves the conductor any risk of bad debts and the member any risk of losing large sums on the journey. The conductor can pay all hotel bills on the route by cheque. We come, therefore, to the second part of our subject.

On the Tour. First of all the conductor must be early at the meeting-place to introduce himself to all the members, and then to introduce them, to some extent, to one another. A great help in this will be found if all luggage is labelled with distinctive tags, such as all one colour, or the patent ones imprinted with one large initial in common, but each a different number and tear-off counterfoil. These are supplied by Messrs. Perry & Perry, 26, Duke Street, St. James Street, London.

Having collected all baggage under one porter, and ascertained that all members are present, it is now time to register. Here a small economy is at once effected. Generally, so many pounds per person is allowed free, or a minimum charge per person is made. By weighing together the baggage of, say, thirty persons, it may be found that only the weight allowed to ten persons is there, and so twenty minimum charges are saved. That is, if little baggage has been taken by each member. This is an essential condition throughout. Much baggage is a burden to those who go for holiday, and a great worry to the one who is arranging its details. Its conveyance to and from Continental hotels should be included in the specified requirements for which prices are sought. Everybody should be told in advance that more than an average of, say, 28 lb. each must be registered, and attended to by the individual member. They should also be reminded that baggage registered cannot be touched till it is delivered up at the destination. A small handbag, with things required en route, should, therefore, be kept from registration.

The Inner Man. On the outward journey reserved carriages will be found, if proper notice has been given and the time-table submitted has been adhered to. Meals en route are generally best left to the members. Some can take very little while travelling, and others prefer to take a little of the food to which they are accustomed, and thereby save the change of diet till they arrive. It is, therefore, hardly just to include these items in the inclusive charge. But it is helpful if the conductor has ascertained price of breakfast here and dinner there, so that he can wire forward the number of seats to be reserved at a certain buffet. In chatting about such details he will get to know the party better, and also secure introductions between different "sets," which might otherwise develop into undesirable cliques.

Of course each hotel will be advised as to the exact hour of arrival, the first meal desired, the total number of beds required, and the number of rooms in which these must be arranged. Nearly all beds are single. The average party requires two rooms for three persons. On arriving at the hotel the proprietor should hand to the conductor a copy of the party-list sent him in advance, with the room number opposite each name, or set of names where friends' names are bracketed. A good wash, a change of dress, and a hearty meal, and, above all, a good night's rest, will put everybody at once into a state of forgetfulness about the tedium of the journey.

The Duties of the Leader. It has now become a question whether the conductor will be at liberty during the day to enjoy

himself like other people, or whether he will be the constant leader of an almost uniformly large party. He should have a definite understanding about this at the beginning, whether the excursions are covered by a season ticket, or whether each member has a "rundreise" ticket covering only the absolutely necessary travel of the tour. Of course the season ticket favours people conducting themselves, and in any case that method is greatly to be encouraged. The members get more interest and instruction out of the holiday that way, and the conductor more relief. When it has been arranged to stay for a whole week at each of two centres the tendency becomes very strong for small groups to make their own arrangements day by day.

This is the ideal thing for everybody concerned. It is a great help, however, if the conductor can sketch out one or two possible excursions for each succeeding day, and indicate times of departure and return ; also fares, where they will be involved.

Underneath each excursion so sketched friends can sign who would like to join in that particular excursion. Another column can be left for those to sign who will be away from the hotel all day. Then, where the midday meal has been included in the hotel accommodation, proper notice can be given for those who would like lunch packed.

The Wet Day Programme. The conductor will find the duty naturally devolve upon him of providing something for the evenings and on wet days. He need not arrange concerts or start games ; but if he does not, he must inspire someone else to do so. Then on Sundays he must be able to announce where English services are held, and of what kind. He must, moreover, in lonely places, arrange for voluntary services if the party desire it and there are members willing to conduct the same. To many who join such companies Sunday may become the most pleasant or the most disappointing memory of the whole tour.

All dealings with the hotel proprietor should be concentrated in the conductor, and all tipping of the servants should be done by him. As a rule, twopence per day per person in the party, wisely distributed according to the proprietor's suggestion, will give satisfaction. Some part of this is well distributed at first and also during the tour. If the conductor seizes occasions that arise, such as late return from excursion, or extra help in interpretation, and bestows occasional gratuities instead of saving all to the end of sojourn, he can do much to make his party welcome at the hotel.

Grumbling. It should also be an honourable understanding, constantly insisted upon, that all complaints must be made to the conductor, and to him alone. It may be that none will occur ; but if some small cause of disappointment does arise it is not fair that it should be discussed in the party until the conductor has had fair chance to put it right.

Attention to details such as these, and to others which will readily suggest themselves in the course of the holiday, do much to secure the pleasure of all concerned. Whilst the conductor thus inevitably has more trouble than any other, he has also a great satisfaction in seeing so many thoroughly enjoy what might be an impossible pleasure if he had not undertaken for them.

Sample of Cost. We shall now make a calculation of the cost of a Swiss tour on the lines indicated above. Very exact figures are not given, as they may vary in different years and will vary in any one year according to the route which may be selected ; but the following may be safely trusted as an average guide, and are quite the outside figures for a moderately conducted tour extending over 18 days :

	£	s.	d.
Ret. 2nd party fare, London to Basle, available for independent return within 25 days, say ..	£3	10	0
[Ordinary individual return fare, as above, £5 5s.]			
Hotel accommodation, including room, light, attendance, breakfast and evening dinner, porterage of baggage to and from station ; 14 days, at 7s. per day	4	18	0
Margin to cover postal and other incidental expenses—*e.g.*, gratuities, preliminary advertising, and unexpected losses or miscalculations	1	2	0
Swiss season ticket, 3rd class, available 15 days, but not 15 nights, and making a wonderful variety of excursions possible at no extra expense	1	10	0
	£11	0	0

Extras. There are possible extras that should also be pointed out beforehand.

Carriage Drives. These should be optional, even where the drive is a long one and the cost known beforehand, and the journey absolutely necessary to complete the tour. Even in such cases there may be vigorous members of the party who prefer to walk, and may wish to save money by doing so. It would not be just, therefore, to include any such drives in the specified charge.

Channel Steamer. The shipping company will generally reduce greatly the price for transfer to first class if the whole party, or a real majority, take such transfer. This also may be treated very wisely as an extra, but strongly recommended, especially where a long sea passage is involved.

Mountain Railways. These are never included in the Swiss season ticket, except Brunig and St. Gotthard. It would therefore be better to treat them as an extra, on which considerable reductions can be secured by all Swiss season ticket holders, and also by small parties of twelve or sixteen who do not hold such tickets. It is not wise to include these in the main cost, because, again, some members of the party will greatly enjoy a good climb.

Excursions. If the season ticket is not adopted generally, but a "rundreise" ticket is secured for each member of the party to cover

merely the tour arranged inside the country, a great deal may be saved in excursions by taking as much as possible en route from one centre to another. For instance, if Lucerne and Lugano were the two centres, a long but glorious day could be secured by taking Tell's Chapel and the Axenstrasse, with breakfast at Altdorf; then break again at Goeschenen, and drive to Andermatt for lunch, and finally reach Lugano at night. Or, a second instance, with Lucerne and Interlaken as two centres: on the day of change a magnificent excursion to the sights of Meyringen and the Geissbach (Fall) may be arranged. Such an arrangement can always be made on the day of change, and save both time and money.

Profits. These will vary according to the idea which leads to the formation of the party. If a minister in a church, or a chief teacher in a large school, or some manager in a business promotes the party with a view to bringing such pleasure within the reach of those whom they desire to help, he will generally be content with the free ticket which can often be secured from the railway company for him, and with the free hotel accommodation which the proprietor will often concede to him as conductor. If he drafts his programme with such an idea as this, he should arrange for part of the margin, allowed in the above sample of cost, to be a weekly levy. This would then protect him completely against any unexpected losses. If it is worked for a larger gain than this, the margin set down would probably provide for a second member of the party to get a free holiday, if all calculations had been carefully made. If it is worked as a purely business affair, then a percentage must be added as profits to the actual estimated cost. Worked on that basis, however, the private party will find it more than difficult to compete with tourist agencies.

Recommendations to Members. The conductor will be wise if he issue to every member of the party a list of instructions and recommendations. It is better to assume that the member is ignorant of the most elementary necessities for the excursion. We subjoin a form of letter which embraces the points to which notice should be directed.

DEAR SIR OR MADAM,

You may be glad of a few hints to prepare for our excursion. A list of hotels for addressing letters will be sent just before we start, with railway tickets, luggage labels and any final instructions.

Luggage: This should be as light as possible. In Switzerland only hand-baggage is free. The trouble, delay, and expense caused by registration make it therefore undesirable to have more. Porterage will be arranged to and from hotels. Through registration will be effected *together* from London to our destination, if possible.

Outfit: Washing can be done easily and cheaply en route. Evening-dress is not necessary. The following articles should be remembered: Toilet requisites and soap; slippers or light shoes; walking boots, light and flexible, but strong and worn to comfort beforehand; light mackintosh or cycle poncho; broad-brimmed hat and cap; only pilgrim-baskets, hold-alls, or gladstone bags should be used, no heavy portmanteaux or trunks.

Refreshments: It is a great convenience as well as economy to have an ample store of sandwiches, etc., packed for the journey. An outfit for making tea, and a supply of tea will always be found most useful.

Money: The balance due should be brought in Bank of England notes. All money can be changed by conductor. Tips will be given for party together and levied with porterage.

Sundry Items: Cameras, flower-presses and tins will be very useful. Music, etc., for evenings and wet days will be welcome. It is expected that all will do their best to help on friendly feeling. Complaints (if any) should be made at once and only to the conductor. Any suggestion will have every consideration.

Anticipating a very happy time together,

I am, yours heartily,

(Signed).

Books to Study. The volume to be mastered first and studied most will cost nothing. It is the Continental time-tables of the company by which the party travels. All the paragraphs about baggage registration and examination, routes and conveyances should be carefully gone through. Any that can apply to the party should be marked. The time-tables which touch the route selected should also be all taken out and pinned with pages on which those paragraphs are found. It will be very helpful to send to a bookseller in the country for the local railway guide so that journeys in the country may be mapped out before starting, and so save labour of choosing trains during the holiday.

Beside these there is probably no book so useful as a Baedeker. The tours sketched at the beginning are always suggestive of a wise expenditure of time where the desire to cover much ground prevails. Cheaper guides in such series as those published by Bradshaw, Cook, Lunn, and especially Paterson's, issued by Oliphant, may be well recommended to the party. It will make the holiday more interesting to the party and much less laborious to the conductor if some have read up well. An ordnance map should be ordered from a native bookseller. The money order sent for this may be made to cover cost of railway guide.

Then a few books relating to the rendezvous may be usefully recommended in the circular of instructions. Of course this will be for reading before or after the holiday. *E.g., Paris*—Zola's "Paris" or Dumas' "Bastille"; *Switzerland*—Schiller's "William Tell" (Scott), or Ball's "Cause of an Ice Age," or Newnes' book on the Social Life of Switzerland.

Continued

GEOLOGICAL WORK OF THE SEA

Continued from page 1638

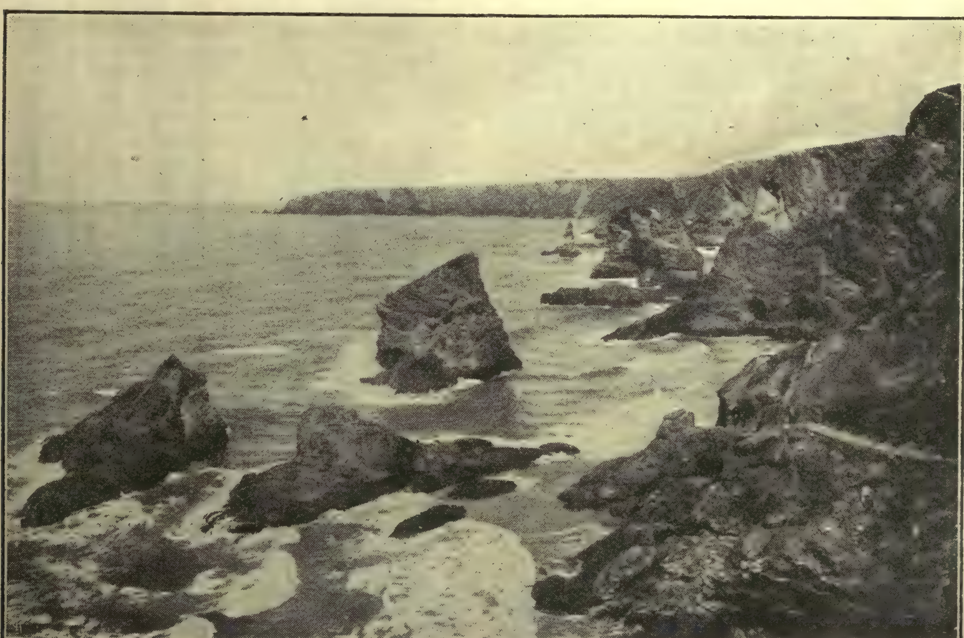
Wave Action and its Results. Organic Life in Geology. Strata. Sedimentary Rocks and Their Formation. The Origin of Fossils. Ancient Sea-beds

By W. E. GARRETT FISHER

THE geological function of the sea is twofold. In the first place it acts as a very powerful erosive agency in attacking the coast-lines of the various continents and islands which it washes. In the second place, all great accumulations of water, both inland lakes and the ocean, act as receiving stations for the vast accumulations of detritus, which we have seen to be scraped off the surface of the land by rain and wind, rivers and glaciers, and cause this detritus to be laid down in successive layers, or strata, which have given birth to almost the whole of the sedimentary rocks. We shall first consider the *erosive action* of the sea. We all know that the sea is constantly in movement. The gravitational influence of the sun and moon cause its waters to oscillate in tides [see GEOGRAPHY and ASTRONOMY], which vary in rise and fall from a few inches in enclosed seas, like the Mediterranean, to 60 or 70 feet in confined spaces, like the Bay of Fundy. This rise and fall of the tide plays an important part in the erosive action of the sea

Tidal Action. Where, as on the British coast, there is a normal difference of 10 or 20 ft. between high and low water, the actual rise and fall of the water has a disintegrating effect upon the coast-line. The space between high and low water-marks is generally occupied by a beach consisting of shingle, sand, or mud, which are all alike the disintegration products of the rocks which line the coast. Tidal movement alone tends to widen this beach and make it slope more gradually out to sea. Where the coast is bounded by precipices of hard rock-like granite the beach may be altogether absent, and the water simply rises and falls against the cliff, as it does against the quay or breakwater of a harbour.

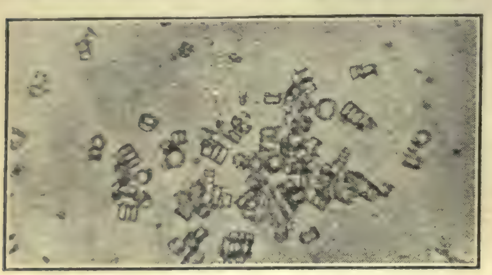
Erosion by the Waves. The chief disintegrating agency of the sea, however, consists in its waves, which are caused by the friction of the wind upon the water. These waves exert tremendous force when they strike upon the cliffs and beaches. In some cases on the coast of Scotland they have been known to exert a pressure of three or four tons on the square foot. The enormous force of these breakers tears off fragments from the solid rock, often many tons in weight, and washes them about like pebbles. These fragments are often launched against the coast-line by the returning wave, and serve as battering rams to increase the destruction. As a rule the sea cliffs are not a solid wall, but are penetrated in all directions by *joints* or *fissures*,



Valentin

68. BEDRUTHAN STEPS, CORNWALL, ILLUSTRATING THE ACTION OF THE SEA UPON THE LAND

which help the disintegrating action of the sea, just as in other cases they simplify the labours of the quarryman. The pressure of the onrushing waves and the air which they drive into all these cracks and crevices gradually enlarges the fissures and joints of the rock, until huge pieces come tumbling down into the sea, where they are washed about and ground together until



69. TRIPOLI POWDER UNDER MICROSCOPE

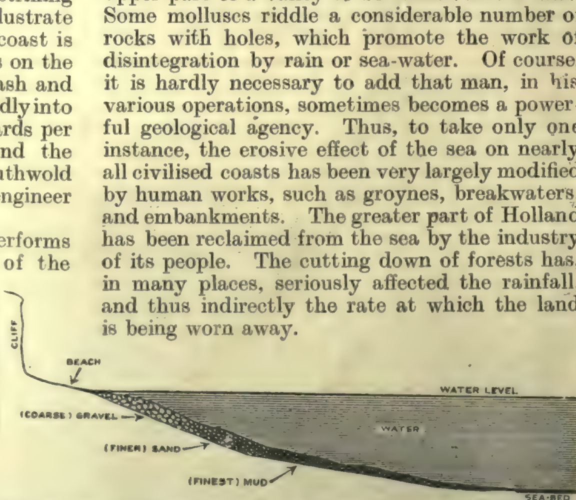
they are ultimately broken up into mere gravel and sand. The vast accumulations of sand that form the ordinary sea-beach are all formed of quartz, one of the hardest of rocks, which has thus been broken down into mere dust.

The actual rate at which the sea carves away the coast-line depends, of course, upon the hardness and structure of the rocks on which it breaks. Granite precipices like those of Peterhead scarcely change perceptibly in the course of a century, though the bold and picturesque features which they present are wholly due to the progress of marine erosion. The striking cliffs of the Cornish sea-board [68] illustrate every stage in the process. Where the coast is composed of comparatively soft rocks, as on the sea-board of East Anglia between the Wash and the mouth of the Thames, the sea eats rapidly into the land ; in some places four or five yards per annum are said to be washed away, and the erosion of our east coast at places like Southwold has become a very serious problem to the engineer as well as to the geologist.

Marine Transport. The sea also performs the work of transport, carrying much of the sediment derived from this erosive process long distances. We shall deal with this part of its action later, when we come to consider the construction of sedimentary rocks. It is enough to note here that, in addition to the ordinary transport of sediment by oceanic currents, a considerable quantity of rough and rocky fragments is carried out to sea by the icebergs which break off from the vast glaciers of polar regions, and travel southward until they ultimately melt and drop their moraine-stuff on to the sea-bed.

Geological Effects of Life. The last agency which we have to consider as helping to break up rocks and rearrange their materials is that of life. Though it is less considerable than the inanimate agencies which we have already described, both *plants* and *animals* have played an important part in the superficial moulding of the earth. Their work is both destructive and reproductive—the latter being more important from a geological point of view. The destructive action of plants is necessarily confined to the superficial layers of the soil, since they can only live in places where they can obtain air and sunlight. The effect of their roots penetrating through the soil and wedging apart the joints of the rocks is sometimes very marked, as we frequently have occasion to see when a tree which happens to have taken root among the ruins of a building is seen to have detached portions of the masonry from its walls, or the growth of some tiny plant is found to have lifted paving stones out of their proper position. The disintegrating effect of plants on the soil, however, is more largely due to the *chemical products* of their decay, which frequently attack various kinds of rock, dissolving or changing their substance.

Animals and their Geological Work. The influence of animals on the soil is not very important, except in the case of the common earthworm, which Darwin proved to be a very diligent fertilising agent. These worms spend their lives in bringing up the deeper particles of soil to the surface, and thus play an important part in the operations of agriculture. Other animals sometimes modify the geological developments of the district by interfering with the courses of streams, as the beaver does in America by building dams which often divert the water into new channels or cause the whole upper part of a valley to be turned into a lake. Some molluscs riddle a considerable number of rocks with holes, which promote the work of disintegration by rain or sea-water. Of course, it is hardly necessary to add that man, in his various operations, sometimes becomes a powerful geological agency. Thus, to take only one instance, the erosive effect of the sea on nearly all civilised coasts has been very largely modified by human works, such as groynes, breakwaters, and embankments. The greater part of Holland has been reclaimed from the sea by the industry of its people. The cutting down of forests has, in many places, seriously affected the rainfall, and thus indirectly the rate at which the land is being worn away.



70. DIAGRAM ILLUSTRATING THE FORMATION OF MARINE DEPOSIT

Rocks Due to Organic Agencies. The *reproductive* action of life upon the earth is extremely important, at any rate, from the human point of view. The *coal measures*, or strata of carboniferous rocks on whose exploitation the modern development of industry has been built, are entirely the product of primeval vegetation which has decayed and been buried

for long ages, to yield up its carbon at last for the use of man, who warms his house and drives his engines by unlocking the energy which these old-world plants once derived from the sunlight.

Soils. The fertility of our richest soils, such as the loam of the American prairies and the black earth of Russia, is due mainly to the long continued growth and decay of the vegetation which has given up its organic residue to mix with the mineral debris, and so form the best kind of soil for agriculture. The well-known Tripoli powder [69], which is used for polishing, mainly consists of the debris of diatoms of tiny plants which have the knack of extracting silica from sea-water and weaving it into their fabric, whence it ultimately accumulates in beds on the sea-bottom. The production of some important metallic ores, such as bog iron ore, is largely due to the agency of vegetation.

Coral and Chalk. Some important rocky formations are due to animal life. Great masses of limestone are derived from the shells of tiny marine organisms which have accumulated on ancient sea bottoms. Coral reefs [see page 558], which are chiefly composed of carbonate of lime, are entirely built up by the animals known as corals, aided—as we saw in an earlier section—by the slow subsidence or upheaval of the land.

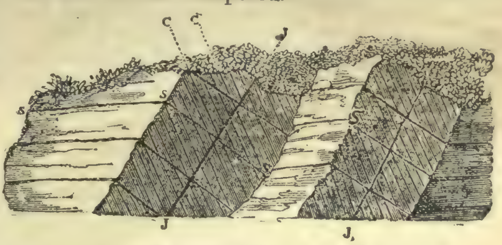
There are great masses of limestone found in the Alps and Pyrenees which were originally deposited as coral reefs in the warm prehistoric seas which once rolled over the sides of these mountains. The great beds of chalk, again, which form so large a portion of southern England, and furnish that most characteristic and beautiful of spectacles, the white cliffs, which look like frosted silver when one gazes at them from the other side of the Channel, consist

72. STRATA SHOWING DIP AND OUTCROP

almost entirely of the tiny shells and skeletons of minute organisms which once lived in the sea, and rained down these tiny shells and skeletons on the sea-bed as they died in countless numbers.

FORMATION OF THE STRATA

We have seen thus far how many agents are at work to wear down the surface of the earth, and disintegrate the primitive rocks. These processes have been at work since the earliest and unrecorded beginning of things. No sooner had the crust of the earth solidified than the agencies of denudation and disintegration began to operate upon the bare and cindery surface of the igneous rocks. At first these agencies were less powerful than they became after the water had liquefied and the action of rivers and seas was added to that of atmospheric influence. But they have ever been at work, abrading the original rocks and wearing them into sand and debris. We have now to see how this loose material was again formed into new rocks, of which the greater part of the earth's surface is now composed.



71. THE FORMATION OF STRATA
S S. Planes of stratification. C C. Planes of cleavage. J J. Joints

As we have seen, the chief influence in the work of denudation and disintegration was running water. But water cannot run down hill for ever ; sooner or later it must sink to a level beyond which it can go no lower, and therefore ceases to move. The bodies of water which represent this lower limit of stagnation are known as *lakes* or *seas*.

Lakes. Lakes are bodies of water occupying depressions on the surface of the land. They may be either fresh or salt. It will usually be found that a fresh-water lake has an outlet for a great part of its waters in the shape of a river. When there is no such outlet and the water brought in by rivers is able to escape only by means of evaporation, the lake inevitably becomes salt, because the rivers are always bringing in a certain amount of dissolved material which is unable to escape, and the chief constituent of this material is common salt—the most readily soluble of all minerals. As the volume of water in a lake usually remains fairly constant, but the quantity of salt is thus being steadily increased, the lake must get salter and salter until its water reaches what is known as the *saturation point*, after which the water can hold no more salt in solution, and for every pound of salt brought into the lake a pound is crystallised out on the shores of the lake.

Seas. What we call seas or oceans are simply vaster lakes which occupy the gigantic depressions which were formed on the surface of the earth by ancient geological agencies. We do not quite know how these depressions were formed. Some of them are probably due to a general subsidence of the land. This is certainly the case, for instance, with the basin of the Mediterranean. There is a possible theory that the vast Pacific Ocean occupies the scar which was left when the huge bulk of the moon split off from the earth, as has been explained in an earlier section. But though the seas and oceans are incomparably larger than any of the

bodies which we call lakes, there is no essential difference between the two. We may speak of the great lakes of North America as inland seas, or of the seas as vast salt lakes. A distinction is usually drawn by geologists between sedimentary rocks which have been deposited in a lake or in the sea, but there is no essential difference.

How Sedimentary Rocks were Formed. It is on the beds of these sheets of water that by far the greater part of the sedimentary rocks have been deposited. It is not difficult now to see how this has happened. We have already seen that every river brings down a considerable body of sediment—fine sand or mud, the débris of the rocks which have suffered disintegration under the various erosive agencies. The greater part of this sediment naturally remains suspended in the water by virtue of its motion. When the water ceases to flow, the sediment gradually sinks to the bottom. This process is illustrated by the familiar experiment of stirring up a bowl full of pea soup, which essentially consists of water containing a greater or smaller quantity of organic sediment—meat fibre and the like. After a thorough stirring the whole of the soup is turbid and fairly homogeneous. But if it be allowed to come to rest and stand for a time a great deal of sediment settles down to the bottom and leaves on the surface a comparatively clear liquid. Exactly the same process is involved in the common injunction to shake a bottle of medicine before pouring out a dose.

Deposit. When a river runs into a lake or the sea, it gradually loses its motion and comes to rest, though, in the case of great rivers like the Amazon or Mississippi, the current may still continue to move for many miles out to sea. As it slows down it steadily deposits its sediment on the bed of the lake or sea. The same thing happens along the bed of the river itself ; whenever it passes into a quiet pool and suffers a temporary loss of speed, the sediment is thus deposited with fair equality in all directions. As time goes on the deposit becomes thicker and thicker, until, if there be no disturbing influence, a great part of the lake may be silted up by these deposits, through which the river goes on its way and keeps merely its own channel open. It is thus that *bars* and *sandbanks* are formed at the mouths of many rivers, and that *deltas* are constructed, stretching far and wide out into the sea.

The Process Discontinuous. As a rule, the process of deposition is not continuous. On the one hand, few rivers run with an absolutely steady current. At one season of the year, when their waters have been fed by excessive rainfall, they come down bank-full with a rapid current thickly charged with sediments of all kinds. At other seasons, when rain is scanty, the volume of the current may be greatly diminished and trickles into the lake or sea almost devoid of sediment. Again, the recipient body of water may at one time be calm and ready to receive the sediment evenly on its bed ; at another time it is convulsed by storms, and the sediment is thrown far and wide and heaped up in irregular accumulations instead of being spread in a homogeneous sheet. It must further be noted that when the deposits thus brought down by rivers become of considerable thickness, their lower portions are subjected to the pressure of the upper ones, which may in time amount to several tons per square inch. In this way the lower portions of the sediment are compressed and hardened into a more or less solid rock, just as powdered graphite and other substances can be made into solid blocks in a hydraulic press.

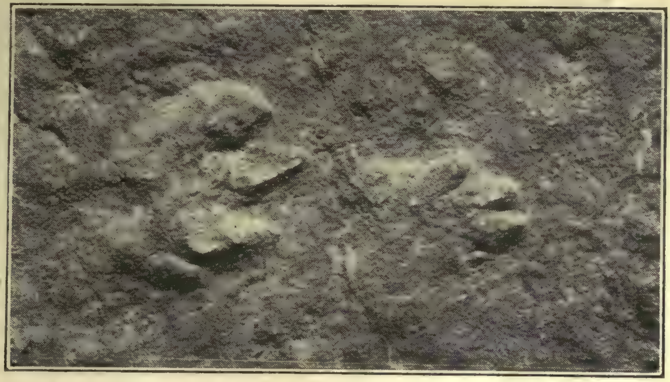
The Strata. We are now in a position to see why it is that the sedimentary rocks are almost always found to be arranged in *layers*, *beds*, or *strata* [**71**]. If the process of deposition were absolutely uniform we should expect to find the sandstones and shales, which are simply hardened deposits of sand or mud, showing no signs of *bedding* or *stratification*. But it is almost always found that the processes of Nature are not continuous, but work by fits and starts. This is generally the case with the deposit of sediment by water. Take the case of the ordinary river ; when its current is full and swift, it brings down a great mass of sediment, which is deposited on the bed of the lake or sea into which it flows ; then, with the change of seasons, comes a period during which little or no sediment is deposited. By the time that the rains again set in and the abundant deposit of sediment begins once more, the lower portion has settled down and formed itself into a roughly horizontal layer, with a well-defined surface, and a slight commencement of hardening on the surface under the pressure of the water. The next accumulation of sediment is spread over this and passes through the same process ; there is usually a well-defined surface of demarcation between the older and the newer layers. This process is constantly repeated throughout long geological ages, and thus the rock which is finally formed on the bed of the sea or lake is found to be divided by planes of stratification or bedding [**71**], which are generally more or less horizontal and parallel to one another. Their thickness will be greater or less, according to the amount of sediment brought down each time the river is in flood, and to the relative intervals which elapsed between the arrival of fresh deposits.

The Origin of Fossils. Of course, the process of forming a sedimentary rock is here reduced to its simplest elements, and a great deal of modifying detail has been omitted. We may note, for instance, that a great deal of extraneous matter will be mingled with sand or mud brought down by the river. The organisms which lived in the water are constantly dying, and their remains settle down upon the floor of the lake or sea, and are there buried under the steady accumulation of sediment. This is the origin of the majority of *fossils*, which are so continually found in sedimentary rocks. The soft parts of the organisms decay, but they may leave their mould in the hardening sand or mud, which is often filled in and preserved for future

ages by some mineral which the water holds in solution. Then the harder portions, such as bones, teeth, or shells, may be preserved almost unchanged, and it is the existence of such relics of long extinct species that enables us to form sound theories as to the gradual evolution of life.

Fossil Vegetation. Vegetation that has been swept into a lake or sea often becomes water-logged, and sinks to the bottom, there to leave its impress upon the growing rocks. A considerable part of the coal measures consists of vegetable matter, which was thus accumulated under water and buried by sedimentary accumulations.

It will thus be seen that the sedimentary rocks have mostly been formed near the shores of lakes or seas. Evidence of this is afforded by the fact that a large number of sandstones and shales bear proof of having been alternately covered and deserted by the sea as they were being formed. The sea-beach between high and low water-marks is simply a sedimentary rock in process of deposition. As the tide ebbs and flows it is alternately exposed to the air and dried by the sun, and then buried under the waves. As a rule, any markings which are made upon it by the rain, the footsteps of animals, or the elementary sculptures of the human child, are washed out by the return of the sea. But sometimes these marks have been preserved.



73. SANDSTONE, WITH FOSSIL FOOTPRINTS OF THE LABYRINTHODON, AN EXTINCT REPTILE

Footprints on the Sands of Ancient Seas. Where a beach is composed of mud rather than sand, its surface may dry so hard in the sun that any marks thus left upon it are retained [73] until a new layer of sediment is deposited upon them, and thus they are preserved to interest geologists of a future age. Many shales and other mud rocks when split open are found thus marked with the footprints of prehistoric animals, or pitted with the raindrops and sun-cracks of days that knew not man. If we take these markings in conjunction with the fossil remains that are found in the same rocks, and which all belong to creatures living in shallow water or between the limits of high and low tide, it is quite clear that such rocks were laid down at the edge of an ancient sea-beach. It is thus possible to trace the limits of long-forgotten seas and oceans, and to make maps of the distribution of land and ocean at various periods in the history of the earth, from which we see that the existing arrangement of the surface in this respect is quite recent.

British Geological History. Thus, to take a few examples from our own island record, we know that in the earliest Primary age the greater part of our islands was under the sea, but not far from a continent, whose rivers washed down the sand and mud which composed the slaty beds of Wales. The rocks on the top of Snowdon consist of volcanic ashes which were deposited on the floor of this shallow sea. In a later Devonian age, reef-building corals were at work in the warm seas which must then have covered the south-western parts of our islands. Their record is found in the limestones of Devonshire. The old red sandstone points to a period in which a great part of our islands was dry land, intersected by numerous arms of the sea, or perhaps covered by vast fresh-water lakes, on whose beds these rocks, so rich in fossils, were deposited. The great coalfields which have made our country so prosperous indicate that there was a time when semi-tropical vegetation covered great parts of the land, which must then, of course, have been raised again above the sea, into which it subsided once more in order to allow of the deposit of the sandstone which overlies the coal measures in so many places.

A British Sahara. The New Red Sandstone is thought to have been laid down under desert conditions, when our country formed part of a vast continent with a warm and extremely dry climate—not unlike that which now obtains in the Desert of Gobi or the Sahara. We can almost watch the gradual irrigation of this arid region by natural processes, and the appearance here and there of lakes, each of which has left its traces in deposits of gypsum and of rock salt. Once again the British area was submerged beneath the Jurassic seas, inhabited by strange fishy forms, whose beds were covered with sediment almost as fast as they continued to sink, so that many thousands of feet of sediment were coagulated into rock, and the seas remained comparatively shallow. The great chalk deposits, again, point to yet another age of submersion, followed by an Eocene period in which our country was occupied once more by land animals. Another continental period followed, and then came the ice age, on the very threshold of modern times. All this history, with much more that will be found detailed in the works on the subject, is deeply engraved on the rocks and written in the everlasting hills.

Continued

Group 21 MATHEMATICS 13 Continued from page 1717	# ALGEBRA **Terms and Operations. Definitions. Simple Substitutions. Positive and Negative Quantities. Addition. Subtraction**

By HERBERT J. ALLPORT, M.A.

DEFINITIONS

1. Algebra, like Arithmetic, deals with the properties of numbers. Algebra, however, has much greater scope than Arithmetic; for, in Arithmetic, numbers are represented by *figures*, each figure having only one meaning; but in Algebra, numbers are represented by *letters*, and each letter may have any value we please, the only limitation being that, in any particular investigation, a letter keeps the same value throughout. Since the letters may have any value whatever, the results obtained must be equally true of all numbers. Thus, in Algebra, we are able to *generalise* the results obtained in Arithmetic.

2. The chief operations are the same as in Arithmetic—*viz.*, addition, subtraction, multiplication, division, and are expressed by the same signs, $+$, $-$, $\times$, $\div$. Thus, $a + b$ means that the number which is represented by b is to be added to the number which is represented by a. Similarly, $a - b$ means that the number represented by b is to be subtracted from the number represented by a. If we do not know the actual numbers which a and b represent, we can go no further than writing the results in the form $a + b$ and $a - b$ respectively. When two letters, or a number and a letter, are to be multiplied together, the multiplication sign is usually omitted, or it may be replaced by a dot. Thus, $a \times b$ may be written either in the form $a.b$ or ab. The latter is more usual. Similarly, $3 \times x \times y \times z$ is contracted into $3xyz$.

As in Arithmetic, division is also denoted by writing the dividend above the divisor, with a line between them, so that $a \div b$ and $\frac{a}{b}$ each mean that a is to be divided by b.

3. When two numbers are multiplied together the result is called the product; or, if more than two are multiplied, the *continued product*. Each number is called a factor of the product.

If we separate the factors into two groups, either group is called the co-factor, or the *coefficient*, of the other. If one of the factors is expressed in figures it is called the *numerical coefficient* of the other factors.

In the product $3xyz$, 3 is the numerical coefficient, xy is the coefficient of $3z$, z is the coefficient of $3xy$, and so on.

The definitions of *power*, *index* (or *exponent*) and *root* given in Arts. **138** and **139** of Arithmetic also apply to Algebra.

Thus, the fifth power of a means $a \times a \times a \times a \times a$, and this is abbreviated into a^5, and read "a to the fifth."

4. An *algebraical expression* is a collection of symbols, such as $3x^2y + 4xyz \div 2z - 6$. The parts of an expression which are connected by the signs $+$ and $-$ are called its *terms*. Thus, the above expression consists of three terms—*viz.*, $3x^2y$, $4xyz \div 2z$, and 6. It should particularly be noticed that $4xyz \div 2z$ is *one* term, so that $4xyz$ is to be divided by $2z$ *first*, and the result added to $3x^2y$. From this last result, 6 is to be subtracted.

This explains the reason for the statement in Art. **87** of Arithmetic. In the example there given $\frac{3}{4} \div \frac{7}{8}$ forms one term of the expression $\frac{3}{4} \div \frac{7}{8} + \frac{5}{8}$, and therefore its value must be found before the remaining term can be added to it.

5. A *simple* expression, or monomial, contains only one term; a *compound* expression contains more than one. A compound expression of *two* terms is also called a *binomial* expression; one of *three* terms is a *trinomial*; one of *more than three* is a *multinomial*.

6. Brackets are used in the same way as in Arithmetic [Art. **84**]. In addition to the ordinary forms of brackets, a straight line called a *vinculum* is used. The line is drawn over the expression which is to be treated as a whole; thus, $2a - (c - \overline{a + b})$ has the same meaning as $2a - \{c - (a + b)\}$.

SUBSTITUTIONS

7. We shall now work examples to illustrate the foregoing definitions.

Example **1.** If $x = 3$, what is the value of (i.) x^4, (ii.) $4x$?

x^4 means the continued product of four quantities each equal to x.

$$\begin{aligned} \therefore x^4 &= x \times x \times x \times x \\ &= 3 \times 3 \times 3 \times 3 \\ &= \underline{81\ \textit{Ans.}} \end{aligned}$$

$4x$ means the product of the two factors 4 and x.

$$\begin{aligned} \therefore 4x &= 4 \times x \\ &= 4 \times 3 \\ &= \underline{12\ \textit{Ans.}} \end{aligned}$$

Example **2.** If $a = 1$, $b = 2$, $c = 3$, find the value of $5abc^2$.

$$\begin{aligned} 5abc^2 &= 5 \times a \times b \times c \times c \\ &= 5 \times 1 \times 2 \times 3 \times 3 \\ &= \underline{90\ \textit{Ans.}} \end{aligned}$$

Note that the index, 2, only refers to the letter after which it is written. $5abc^2$ does *not* mean that we are to find the value of $5abc$ and square the result.

Example **3.** If $a = 5$ and $b = 2$, find the value of $\sqrt{5a^2 - b^2}$.

$$\begin{aligned} \sqrt{5a^2 - b^2} &= \sqrt{5.a.a - b.b} = \sqrt{5.5.5 - 2.2} \\ &= \sqrt{125 - 4} = \sqrt{121} = \underline{11\ \textit{Ans.}} \end{aligned}$$

Example 4. When $x = 2$, $y = 1$, and $z = 3$, show that

$$\frac{3x+y-z}{x-2y+z} - \frac{\sqrt{x^2+3y^2+z^2}}{\sqrt[3]{5x^3-3y^3+z^3}} = \frac{y}{z}.$$

The expression on the left

$$= \frac{6+1-3}{2-2+3} - \frac{\sqrt{4+3+9}}{\sqrt[3]{40-3+27}}$$

$$= \frac{4}{3} - \frac{\sqrt{16}}{\sqrt[3]{64}} = \frac{4}{3} - \frac{4}{4} = 1\tfrac{1}{3} - 1 = \tfrac{1}{3} = \frac{y}{z}.$$

Example 5. If $x = 5$ and $y = 2$, find the value of

$$2x - [1 + 3\,(x - \overline{1+y})].$$

The given expression

$$\begin{aligned} &= 10 - [1 + 3\,(5 - \overline{1+2})] \\ &= 10 - [1 + 3\,(5-3)] \\ &= 10 - [1 + 3 \,.\, 2] \\ &= 10 - [1+6] \\ &= 10 - 7 = \underline{3 \; Ans.} \end{aligned}$$

After substituting the values of the letters, we proceed exactly as in the example worked out in Art. **84** of Arithmetic.

8. If one factor of a product is 0, the product itself will be 0. Also, any power of 0 is 0. Hence, if we are required to find the value of such an expression as $a^2bx + 3ab^3 + 4a^2x^2$, when $a = 3$, $b = 2$, and $x = 0$, we neglect all terms containing the factor x. Thus, the required value is that of $3ab^3$, or $3 \,.\, 3 \,.\, 2^3$, which equals 72.

EXAMPLES 1

If $a = 3$, $b = 1$, $c = 2$, find the value of

1. $3a^2$. **2.** $4abc^2$.

3. $a^3 + b^3 + c^3 - 3abc$. **4.** $\dfrac{a+b-c}{a+c-b}$.

5. $\frac{1}{2}a^2b^2c^3 - \frac{1}{3}a^3bc$.

If $x = 6$, $y = 3$, $z = \frac{1}{2}$, find the value of

6. $\sqrt{2x^2 + 3y^2 + 4z^2}$. **7.** $\sqrt[3]{\dfrac{3xy}{z^2}}$.

8. $\sqrt{x+y} \,.\, \sqrt[3]{x + 4y^2 + 7z^3}$.

9. Show that $x^2 - 7x + 12$ is equal to 0 when $x = 3$, and also when $x = 4$. Find its value when $x = 5$.

10. If $a = 4$, $b = 2$, $c = 1$, and $d = 0$, find the value of $(ad + bc)^2 - 2\,(2a^2 - 3b^3) + (c^2d - 2b)^2$.

POSITIVE AND NEGATIVE QUANTITIES

9. The signs + and − have, in Algebra, a wider meaning than in Arithmetic. They are used to denote a *quality* of the quantities before which they are placed. Many quantities may imply either an *increase* or a *decrease*. For example, a sum of money may be received, or it may be paid. Hence, we agree that a quantity which *increases* the quantity we are considering shall be called a *positive quantity*, and have the sign + prefixed; while a quantity which *decreases* the quantity we are considering shall be called a *negative quantity*, and have the sign − prefixed. Thus, in calculating the amount of money a man is worth, + £5 will stand for £5 which he possesses, or which is to be paid to him; while − £5 will stand for £5 which he himself owes. But, if we are estimating the man's *debts*, + £5 will stand for £5 which he owes, while − £5 will stand for £5 which is owing to him.

10. Used in this sense, the sign + is often omitted, so that, when no sign is written before a term, the sign + is understood.

The necessity for distinguishing between positive and negative quantities has led to the word "sign" being applied only to the + and −, and not to the × and ÷. Thus, when we speak of *the sign* of a quantity, we mean the + or the − placed before it.

11. The magnitude of a quantity, considered independently of its sign is called its *absolute magnitude.*

ADDITION

12. When two terms contain the same letters, and the corresponding letters in each term are raised to the same power, they are called *like* terms. If the corresponding letters are not raised to the same power, they are called *unlike* terms.

Thus, $4xy^3z^2$ and $-2xy^3z^2$ are *like* terms, since each contains the letters x, y, z, and x is raised to the first power in each, y to the third power, and z to the second power. But $3a^2b$ and $2ab^2$ are *unlike* terms, since, although they contain the same letters, the letters are not raised to the same power in each.

13. A positive quantity makes an increase, and a negative quantity a decrease. Hence, to add a positive quantity to any expression, we *add* its absolute magnitude; and, to add a negative quantity, we *subtract* its absolute magnitude.

Thus, if we add $+2a$ to $+3a$ we get $+2a + 3a$; while, if we add $-2a$ to $+3a$, we get $+3a - 2a$.

Therefore, *to add a term to an expression, write the term after the expression, with its sign unchanged.*

Again, it is clear that to add an *expression* gives the same result as if we add the *terms* of the expression separately.

For example, if we add the expression $a + b - c$ to x we shall obtain the same result as if we first add the term $+a$ to x, then the term $+b$, and finally, the term $-c$.

Hence, *to add two or more algebraical expressions together, write down all the terms in succession, with their signs unchanged.*

14. After writing down all the terms we must collect together all terms which are *like* [Art. 12].

For this, we have the following rules:

1. The sum of like terms is a like term.

2. If the terms all have the same sign, add the coefficients. Prefix the same sign to the result. This will be the coefficient of the sum.

3. When some of the like terms are positive, and some negative, (i.) add the coefficients of the positive terms; (ii.) add the coefficients of the negative terms; (iii.) take the difference of these results, and prefix the sign of the greater. This gives the coefficient of the sum.

Example 1. Add together a^2, $5a^2$, $9a^2$, $11a^2$.

$$\begin{aligned} &a^2 + 5a^2 + 9a^2 + 11a^2 \\ &= (1 + 5 + 9 + 11)a^2 \\ &= \underline{26a^2 \; Ans.} \end{aligned}$$

We add together the four coefficients—*viz.*, $+1$, $+5$, $+9$, $+11$, giving $+26$ for the coefficient of a^2 in the required sum.

Example 2. Find the sum of $-12x^2y$, $-4x^2y$, and $-17x^2y$.

$$\begin{aligned} &-12x^2y-4x^2y-17x^2y \\ &= -(12+4+17)x^2y \\ &= -33x^2y \ \textit{Ans.} \end{aligned}$$

Add together 12, 4, and 17, and put the same sign, *viz.*, $-$, before the result; giving -33 for the coefficient of x^2y.

Example 3. Add together $5abc$, $-9abc$, $-2abc$, $3abc$, $-4abc$.

$$\begin{aligned} &5abc-9abc-2abc+3abc-4abc \\ &= 8\,abc\ -\ 15abc \\ &= -7abc \ \textit{Ans.} \end{aligned}$$

We find the sum of the positive terms as in Ex. 1, and the sum of the negative terms as in Ex. 2. Finally, to obtain the sum of $8abc$ and $-15abc$, we take the difference between 8 and 15, and prefix the sign of the greater number, the result being $-7abc$.

15. When the expressions to be added contain several sets of like terms, we proceed as above with each set separately.

Example 1. Add together $4bc-3ca+ab$, $5ca-6ab$, $-7bc+ca+2ab$.

The sum

$$\begin{aligned} &= 4bc-3ca+ab+5ca-6ab-7bc+ca+2ab \\ &= \underbrace{4bc-7bc}-\underbrace{3ca+5ca+ca}+\underbrace{ab-6ab+2ab} \\ &= \quad -3bc \qquad\qquad +3ca \qquad\qquad -3ab \ \textit{Ans.} \end{aligned}$$

NOTE. The second line of work is merely a rearrangement of the first, and is not necessary. It is introduced to show clearly how the third line is obtained.

It is more usual to arrange the terms in columns, with like terms in the same column.

The above example then appears thus:

$$\begin{array}{rrr} 4bc & -\ 3ca & +\ ab \\ & 5ca & -\ 6ab \\ -7bc & +\ ca & +\ 2ab \\ \hline -3bc & +\ 3ca & -\ 3ab \ \textit{Ans.} \end{array}$$

Generally, we combine the terms in the left-hand column first, and so on, working from left to right; but this, of course, is quite optional.

Example 2. Find the sum of $\frac{3}{2}a^2b-\frac{1}{4}ab^2+a^3$, $\frac{1}{2}a^3-\frac{1}{4}a^2b+\frac{3}{2}ab^2$, ab^2-a^2b.

$$\begin{array}{rrr} \frac{3}{2}a^2b & -\ \frac{1}{4}ab^2 & +\ a^3 \\ -\frac{1}{4}a^2b & +\ \frac{3}{2}ab^2 & +\ \frac{1}{2}a^3 \\ -a^2b & +\ ab^2 & \\ \hline \frac{1}{4}a^2b & +\ \frac{9}{4}ab^2 & +\ \frac{3}{2}a^3 \ \textit{Ans.} \end{array}$$

We have a column for the terms a^2b, another for ab^2, and a third for a^3. In writing the columns, note that we have to insert the sign $+$ before $\frac{1}{2}a^3$ and before ab^2, these terms having no sign in the given expressions, $+$ being therefore understood [Art. 10]. If the fractional coefficients cannot be added mentally, we proceed as in Arts. 80 and 81 of Arithmetic.

SUBTRACTION

16. Subtraction is the reverse of addition. Therefore, if to some expression we first add a quantity, and then subtract the same quantity, the expression remains unaltered.

Hence, $x+y-y$ is the same as x.

Now, if from the expression $x+y-y$ we take away the $+y$, we have $x-y$ left. That is, if we take away $+y$ from x we have $x-y$ left.

Similarly, if from $x+y-y$ we take away the $-y$, we have $x+y$ left. That is, if we take away $-y$ from x we have $x+y$ left.

We have, therefore, these two results,

$$x-(+y)=x-y$$
$$x-(-y)=x+y$$

from which we obtain the rule: *To subtract a term from a given expression, write it after the given expression, but with its sign changed.*

Again, to subtract an expression as a whole will plainly give the same result as subtracting the terms of the expression separately.

Hence: *To subtract one expression from another, write all the terms of the one expression after the other expression, but with their signs changed.*

17. After writing down the terms, we collect like terms exactly as in addition.

Example 1. From $5x-2y+z$ take $-x+3y-z$.

Writing the second expression, with all the signs changed, after the first expression, we get

$$\begin{aligned} &5x-2y+z+x-3y+z \\ &= 6x-5y+2z \ \textit{Ans.} \end{aligned}$$

The work is often arranged as for addition, the expression to be subtracted being written underneath the other, with like terms under like terms. The signs of the lower line are changed *mentally*.

The above example then appears thus,

$$\begin{array}{lrrr} \text{From} & 5x & -\ 2y & +\ z \\ \text{take} & -x & +\ 3y & -\ z \\ \hline & 6x & -\ 5y & +\ 2z \ \textit{Ans.} \end{array}$$

Say, $+x$ and $5x=6x$
$-3y$ and $-2y=-5y$
$+z$ and $z=2z$.

Example 2. Subtract $x^3-2x^2y+y^3$ from $-x^3+2xy^2+2y^3$.

$$\begin{array}{lrrrr} \text{From} & -\ x^3 & & +\ 2xy^2 & +\ 2y^3 \\ \text{take} & x^3 & -\ 2x^2y & & +\ y^3 \\ \hline & -2x^3 & +\ 2x^2y & +\ 2xy^2 & +\ y^3 \ \textit{Ans.} \end{array}$$

Say, $-x^3$ and $-x^3=-2x^3$
$+2x^2y$ and $0=2x^2y$

and so on.

EXAMPLES 2

Find the sum of

1. $3ab+2ca-6bc$; $-4ab+ca+3bc$; $2ab-2ca+4bc$.
2. x^3-2x^2+1; $3x+4x^2-2x^3$; $-5-2x$; $-3x^2-x^3+6$.
3. $\frac{2}{3}x-\frac{4}{5}y+\frac{5}{6}z$; $-\frac{1}{9}x+\frac{1}{10}y-\frac{1}{12}z$; $-\frac{1}{18}x-\frac{3}{10}y-\frac{1}{4}z$.
4. $ax^2-a^3+3x^3$; $2a^2x+x^3-4ax^2$; $3a^3-5x^3$; $2ax^2-3a^2x+a^3+x^3$; $-ax^2-a^2x-3a^3$.

Subtract

5. $ab+cd-bd$ from $-ab-2cd+3bd$.
6. $5x^2y-3xy^2+x^3$ from $2xy^2-3x^2y-y^3$.
7. $\frac{1}{2}a+\frac{1}{3}b-\frac{1}{4}c$ from $\frac{1}{3}a-\frac{1}{4}b+\frac{1}{2}c$.
8. $6a^4-2a+3-a^2$ from $a-1+3a^3-a^4$.
9. From the sum of $7x-4+3x^2$ and $2x^3-4x+1$ take x^3-x^2+x-1.
10. Add the sum of $3y-y^3+2$ and $1-4y^2-y$ to the remainder left when $3y-6y^3$ is subtracted from $1-2y$.

Continued

MACHINES AND APPLIANCES

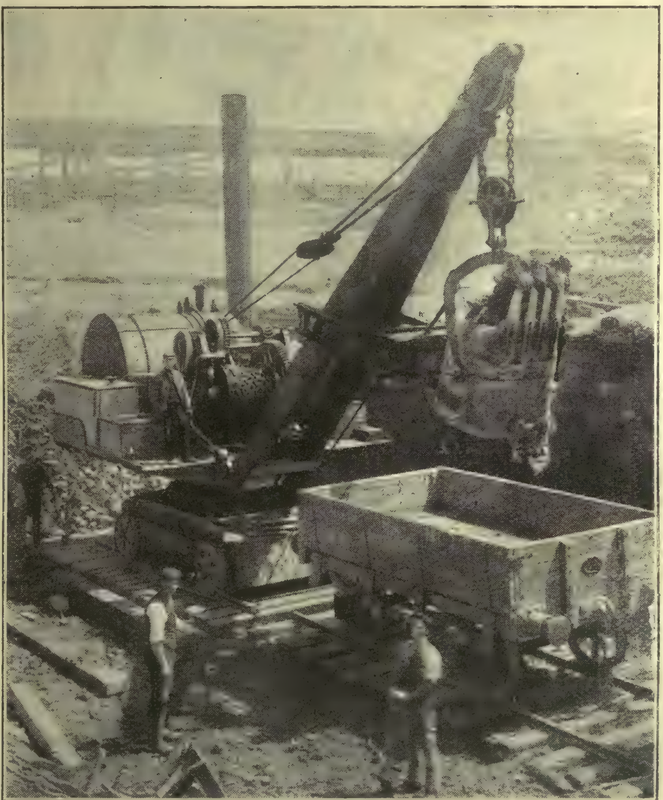
Machinery for Cuttings, Trenches, Tunnelling, Rock-cutting, Dredging, and Pumping. Locomotives, Tip Waggons, and Dobbin Carts

Continued from page 1647

By Professor HENRY ADAMS

Responsibility of Contractors. The machinery and appliances used by a contractor in carrying out works of construction coming under the head of Civil Engineering, vary with the class of work and the magnitude of the contract. The contractor has to take the risk of the efficiency of any method he may adopt, and good judgment in the use of means is most essential if he is not to incur an actual loss; but it must be remembered that a contractor's nominal loss is frequently only the loss of further profit that he thinks ought to have been made. The risk is great, and it is only right that the profit should be correspondingly large when good judgment is exercised.

General Tools. The personal tools, such as picks and spades, barrows and wheeling planks, ladders, scaffold boards, blocks and falls, crab winches, crowbars, etc., will always be needed. A portable steam engine, mortar-mill, stone breaker, screens and concrete mixer will probably come next, with horses and strong carts for carrying bricks and earth. Then sheds for storing lime and cement, a smith's forge, a saw-mill, a portable office, and, for a large contract, a light locomotive, trucks and rails, steam navvy or portable excavator, pumps, derrick poles, overhead travellers and gantries, steam cranes, pile engines, etc. When any particular piece of plant is wanted for temporary use only, it may generally be hired at a charge of about 1 per cent. of its value per week, but large contractors find it cheaper to buy outright all they require for use.



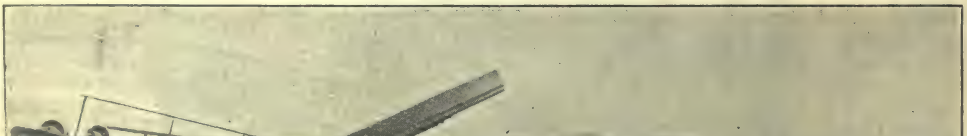
1. STEAM CRANE EXCAVATOR AT WORK

Excavating Machines. A navvy's pick and shovel and hand-barrow are only used on the smallest work, and machines have been introduced to economise both time and labour. The majority are of the steam crane type, such as **1**, by Wilson & Co., shown at work on the Cruden Railway, near Aberdeen; and **2**, by Ruston, Proctor & Co., Ltd., of Lincoln, shown at work on a railway cutting.

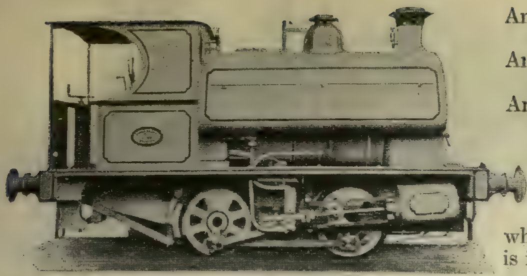
The former has a lifting power of 12 tons, and will excavate and put into waggons 750 to 1,000 cubic yards per day of ten hours, according to the nature of the ground. It will work a clear 22 ft. space and drive a gullet 50 ft. wide, turning round the whole circle. By removing a couple of cotters the digging gear can be disconnected, and the machine then becomes an ordinary 12-ton locomotive crane. Its total weight is about 35 tons. The latter has about the same power, with a different arrangement of gearing. The latest type of appliance for this kind of work is the electric navvy, shown in **3**, and constructed by Ernest Scott & Mountain, Ltd., of Newcastle-on-Tyne.

Contractors' Locomotives. As the waggons are filled they are run by horses to the tip, where the material from a cutting has to make up an embankment, or to be put into

2. STEAM NAVVY AT WORK ON A RAILWAY CUTTING



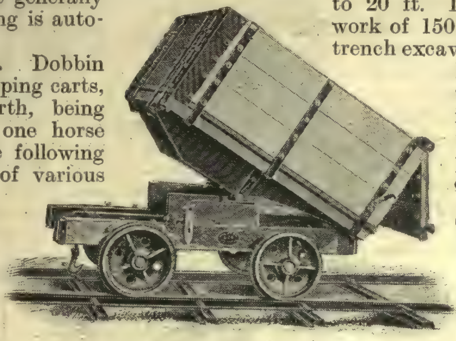
3. ELECTRIC NAVVY AT WORK



4. CONTRACTOR'S LOCOMOTIVE

trains drawn by a contractor's locomotive (such as that in **4**, which is made by the Avonside Engine Co.), where the distance to be travelled is sufficiently great to warrant the additional expense. Tip waggons are generally used so that the unloading is automatic [**5**].

Dobbin Carts, etc. Dobbin carts are small, strong tipping carts, containing $\frac{3}{4}$ yd. of earth, being suitable for drawing by one horse over a rough surface. The following table gives the capacity of various appliances for removing earth :



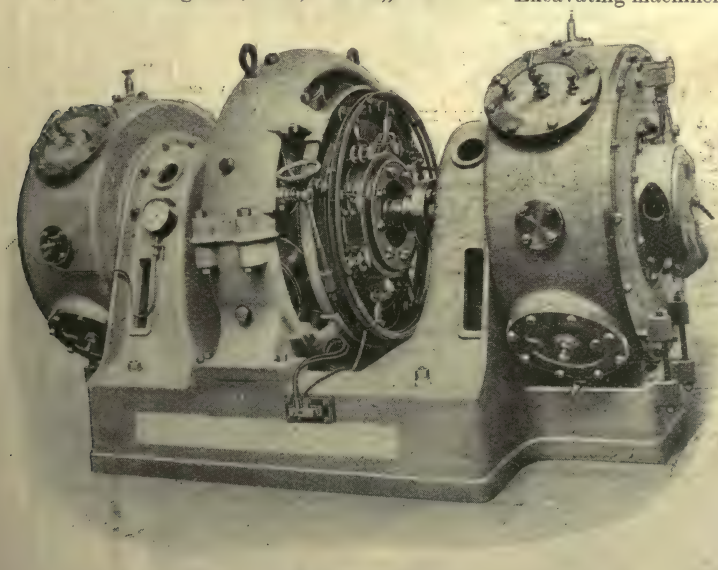
5. CONTRACTOR'S TIPPING WAGGON

		cubic yd.
A wheelbarrow, light	holds	$\frac{1}{18}$
A wheelbarrow, ordinary	,,	$\frac{1}{14}$
A wheelbarrow, large (navvy)	,,	$\frac{1}{10}$
A dobbin cart	holds	$\frac{3}{4}$
A one-horse cart (6 ft. $\times$ $3\frac{1}{4}$ ft. $\times$ $2\frac{1}{3}$ ft.)	,,	$1\frac{2}{3}$
An earth waggon, small, filled to level of sides, as with gravel, sand, etc.	,,	2
An earth waggon, small, when heaped, as with earth or clay	holds	$2\frac{1}{2}$
An earth waggon, large, filled to level of sides	,,	$2\frac{3}{4}$
An earth waggon, large, heaped	,,	3

Pug-mills. When clay from an excavation is required for use to form a water-resisting medium, as in reservoir dams, coffer dams, etc., it is put through a pug-mill, to *temper* it or work it up to a homogeneous mass, in which condition, so long as it is kept moist, it is impervious to water.

Sewer Excavators. A novel form of excavator, by the Municipal Engineering and Contracting Co., shown in **9**, is used in America for cutting the trenches for laying sewers, gas and water pipes, etc. This machine excavates trenches 14 to 60 in. in width and any depth up to 20 ft. It is reckoned to do the work of 150 men. Another form of trench excavator, made by Van Buren, Heck & Marvin, and used with success in America, is shown in **7**. It is geared to travel at a speed of 2 ft. per minute, and is capable of digging trenches up to 12 ft. deep and $4\frac{1}{2}$ ft. wide. The machine shown in the illustration dug a trench 7 ft. deep and 26 in. wide in stiff clay at a rate of 700 to 900 lineal ft. per day. The trench excavating machine, made by The Helm Trench Machine Co., and shown in **8**, is of the bucket dredging principle. This machine is capable of digging trenches of any depth up to 25 ft. and any width from 24 in. to 36 in. by changing the buckets.

Excavating machinery is, perhaps, the innovation of comparatively recent times that has done more than any other to economise the cost of large contracts. In the formation of canals and railway cuttings, where the soil is suitable, nearly the whole of the work can be done by a steam navvy, including the formation of the side slopes; and the trench excavators illustrated above, may be expected to prove as useful for work in the open country in England as they are in America. For town work, there are many cases where they would not be



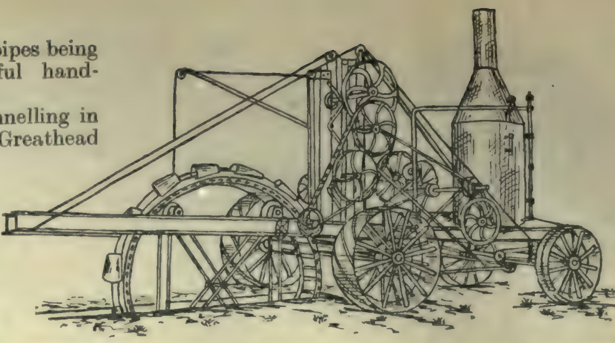
6. AIR COMPRESSOR

applicable, owing to gas and water pipes being in the way, and requiring careful hand-digging, to avoid damage.

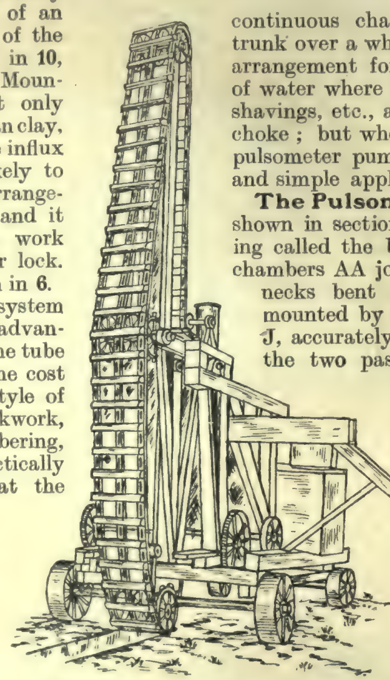
Tunnelling in Clay. Tunnelling in clay is now done by means of the Greathead shield, which is a ring of steel forced forward by hydraulic rams bearing against the cast-iron lining rings, previously fixed. The direction is altered for a curve or gradient by increasing the stroke of the rams on a portion of the circle. The difficulty of driving the small heading in advance of the tunnel proper may be overcome by the use of an electric excavator in front of the Greathead shield, as shown in **10**, which is by Ernest Scott & Mountain, Ltd. Gravel is not only harder to drive through than clay, but it is more subject to the influx of water. When this is likely to enter, special pumping arrangements have to be made, and it may even be necessary to work under pressure with an air lock. An air-compressor is shown in **6**.

The introduction of this system has proved of inestimable advantage in the construction of the tube railways across London; the cost of the work in the old style of tunnelling, with massive brickwork, supported by a forest of timbering, would have been practically prohibitive, and now that the difficulties of ventilation have been overcome, a great extension of the tube railway system may be anticipated.

Pumping Appliances. A chain pump, consisting of float boards attached at intervals to a continuous chain, and drawn up a wooden trunk over a wheel at the top, forms a suitable arrangement for dealing with large quantities of water where there may be any straw, chips, shavings, etc., about, as it is not very liable to choke; but when the water is fairly clean, the pulsometer pump [11] is the most convenient and simple appliance.



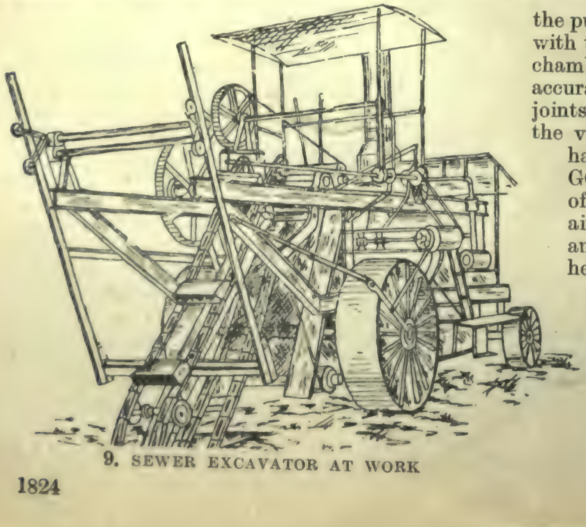
7. BUCKEYE TRACTION DIGGER FOR EXCAVATING TRENCHES



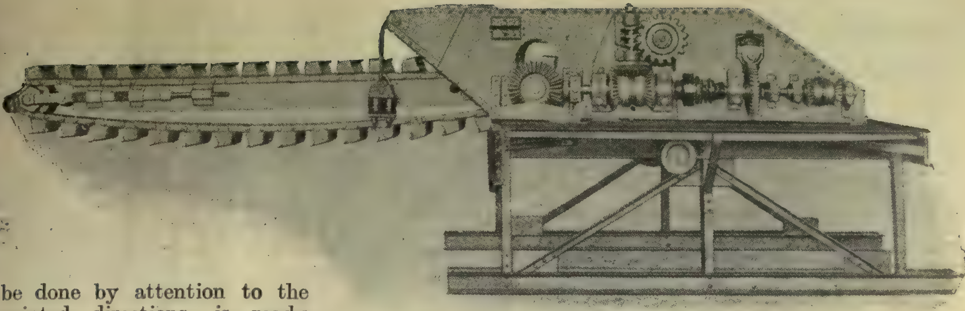
8. TRENCH EXCAVATING MACHINE

The Pulsometer Pump. The pulsometer shown in section in **12** consists of a single casting called the body, which is composed of two chambers AA joined side by side, with tapering necks bent towards each other, and surmounted by another casting called the neck J, accurately fitted and bolted to it, in which the two passages terminate in a common steam chamber, wherein the ball-valve I is fitted so as to be capable of oscillation between seats formed in the junction. Downwards, the chambers AA are connected with the suction passage C, wherein the inlet or suction valves EE are arranged. A discharge chamber, common to both chambers, and leading to the discharge pipe, is also provided, and this also contains one or two valves FF, according to the purpose to be fulfilled by the pump. The air-chamber B communicates with the suction. The suction and discharge chambers are enclosed by hinged covers HH accurately fitted to the outlets by planed joints, and readily removed when access to the valves is required; in the larger sizes, hand holes are provided in these covers. GG are guards which control the amount of opening of the valves EE. Small air-cocks are screwed into the cylinders and air-chamber, for use as will be hereafter described, These are the general outlines of the construction of the apparatus, and they are sufficient for the understanding of the nature of its operations.

Action of the Pump. The pump having been filled with water, either by pouring water through the plug-hole in the chamber, or by drawing the charge, as can readily



9. SEWER EXCAVATOR AT WORK

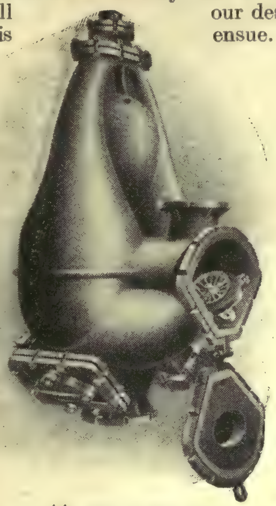


10. ELECTRIC EXCAVATOR FOR USE WITH THE GREATHEAD SHIELD

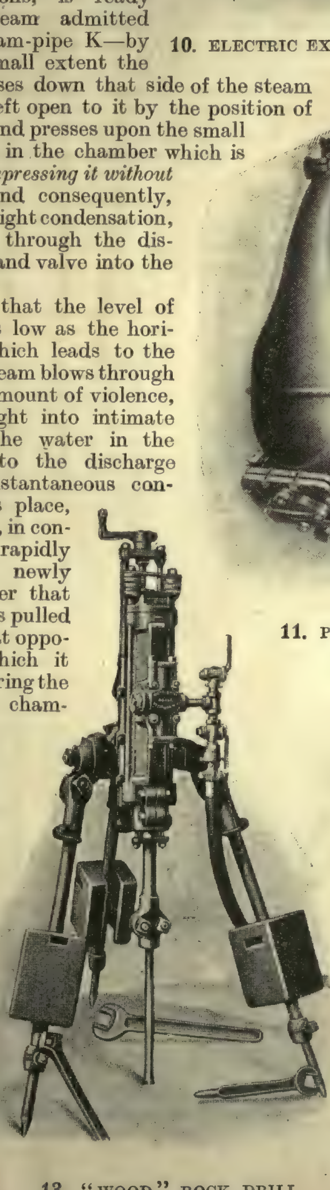
be done by attention to the printed directions, is ready for work. Steam admitted through the steam-pipe K—by opening to a small extent the stop-valve—passes down that side of the steam neck which is left open to it by the position of the steam ball, and presses upon the small surface of water in the chamber which is exposed to it, *depressing it without any agitation*, and consequently, with but very slight condensation, and driving it through the discharge opening and valve into the rising main.

The moment that the level of the water is as low as the horizontal orifice which leads to the discharge, the steam blows through with a certain amount of violence, and being brought into intimate contact with the water in the pipes leading to the discharge chamber, an instantaneous condensation takes place, and a vacuum is, in consequence, so rapidly formed in the newly emptied chamber that the steam ball is pulled over into the seat opposite to that which it had occupied during the emptying of the chamber, closing its upper orifice and preventing the further admission of steam, allowing the vacuum to be completed; water rushes in immediately through the suction pipe, lifting the inlet valve E, and rapidly fills the chamber A again. Matters are now exactly in the same state in the second chamber as they were in the first chamber when we began our description, and the same results ensue. The change is so rapid that, even without an air vessel on the delivery, but little pause is visible in the flow of water, and the stream is, under favourable circumstances, very nearly continuous. The air-cocks are introduced to prevent the too rapid filling of the chambers on low lifts, and for other purposes, and a very little practice will enable any unskilled workman or boy so to set them by the small nut that the required effect may be produced. The action of the steam ball is certain, and no matter how long the pump may have been standing, it will start as soon as dry steam is admitted. A pulsometer pump is shown in operation in **15**, pumping water from an excavation.

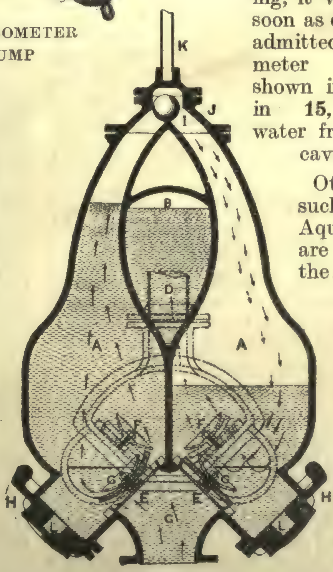
Other pumps, such as Bailey's Aqua-Thruster, are made upon the same principle. Their great advantages are simplicity and portability; they can be applied wherever a steam pipe can be led, and



11. PULSOMETER PUMP



13. "WOOD" ROCK DRILL



12. SECTION OF PULSOMETER PUMP

14. ROCK DRILL AT WORK

can be readily lowered as the water level is reduced.

Rock Cutting. When an excavation or tunnel has to be carried through solid rock, holes are drilled by steam or pneumatic drills or jumpers, such as **13** and **14**, which are made by The Wood Drill Works, U.S.A. Blasting cartridges are inserted to break away the material in portions suited to the quantity to be removed and the space which has to be cleared.

A general knowledge of surface geology is of much use to a contractor in estimating the difficulties he is likely to encounter, but most contractors depend upon their practical experience rather than upon any book knowledge which may be available.

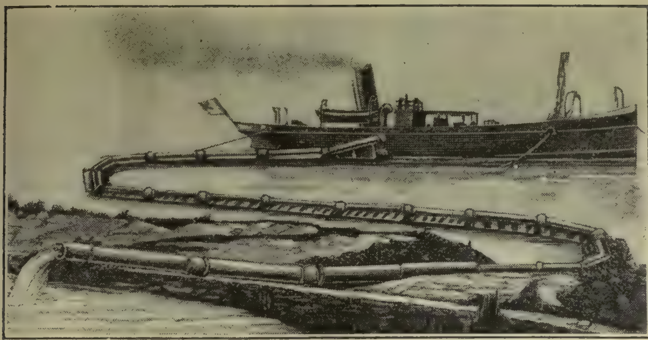
An important matter in carrying out engineering work is to utilise the material found on the spot. Such, for instance, as using flints, ballast, or small broken stone for the aggregate of concrete; burning the chalk or limestone for producing lime; using the rough stone for rubble walling, and the better class of stone for block masonry, and so on.

Dredging Machinery. When the material to be removed is under water, suction dredgers [as **16**, made by J. H. Wilson & Co., of Liverpool], may be used if it is soft mud, sand or silt, and the material may be delivered by pipes to a considerable distance over the banks on either side. One form of dredger found very useful in keeping docks clear of mud consists of an air compressor, placed on board a tug to blow air through a trailing pipe and stir up the mud at the bottom, so that it will float out with the tide. Bucket dredgers [as **17**, by Lobnitz & Co., of Renfrew] are used when the material is more solid; and when it consists of rock, the rock may be broken up by dropping a heavy piece of metal, shod with a hardened steel point, on the Lobnitz system [as **18**].

This system was used on the Manchester Ship Canal, and **19** shows the operation, the rock cutter being suspended ready for dropping through the water on to the rock below. The lumps are then raised by the bucket dredger [**17**], or by hooks substituted for the buckets. The material from a bucket dredger is generally deposited in barges alongside, so that it may be taken away and delivered where it may be of use, or at any rate, where it will do no harm. Hopper-bottom barges are expensive in first cost but save their cost rapidly by the facility they afford for emptying mud and clay out at sea.

In the Thames, steam tugs sometimes have a giant rake dropped from the stern, which they drag through the mud that accumulates in front of jetties where ships are berthed, so that it may be carried away by the tide. This is very cheap, but not so effective as the pneumatic dredger described above.

15. PULSOMETER PUMP AT WORK



16. SUCTION DREDGER AT WORK

is also necessary in clearing obstructions from the roller path of dock gates, clearing the windbore, or snore pipe, or perforated suction end, at the foot of a suction pipe in a dock, and for other practical purposes.

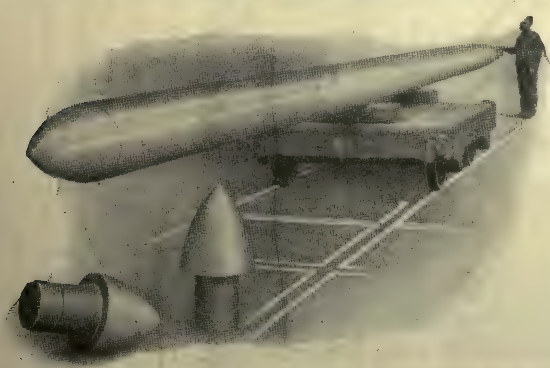
The air compressor used consists of a portable pumping apparatus worked by hand, which has to be kept in constant motion so long as the diver is encased in his dress. The pressure has to be sufficient to overcome the head of water so that the expired air may be discharged without permitting the ingress of water, but any excess of pressure is detrimental to the diver. He usually descends to his work by a ladder, and when more than one diver is at work at the same time, particular care has to be taken by each that the air-pipes and life-lines do not become entangled.

Diving=bells and Dresses. For laying masonry blocks under water diving-bells were formerly in use, but these have now practically disappeared, as diving dresses [such as 20] permit of so much more freedom of action. The diver dresses in flannel for warmth, and then puts on the waterproof dress, in one piece from the feet upwards. Leaden soles to the feet keep him vertical when in the water, and leaden weights suspended by cords, are placed over his shoulders, to hang back and front, as sinkers, to overcome the buoyancy of the inflated dress. The hands remain uncovered, and indiarubber wrist-bands prevent the admission of water there. The opening at the neck is surmounted by a helmet, screwed on, having thick glass windows through which to see. An air-pipe is provided from an air compressor to supply fresh air, the expired air escaping through valves, and a life-line is attached to his body by which signals may be made to the surface.

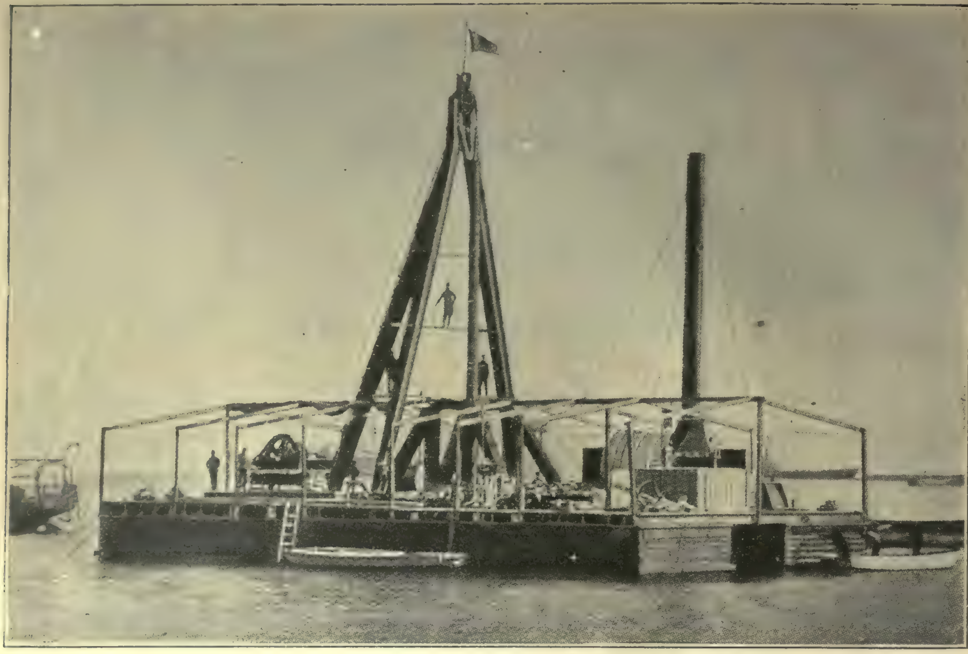
In harbour construction, this method of reaching the work under water is indispensable, and it

17. BUCKET DREDGER AT WORK

The Contractor's Engineer. There are many cases arising in the course of a large contract where a choice of methods is available for executing certain parts of the work, and very large differences may occur in the cost of construction, according to the method adopted. It is here that good judgment is of such primary importance, and large contractors usually employ a trained civil engineer to direct the actual work independently of the resident engineer representing the designer. An engineer loses caste to some extent by accepting such an appointment, but he gains vastly in experience and absolute knowledge, and, with a love for his work, has a much more interesting life than one who merely sits in his office and prepares schemes for others to carry out. There is great risk of the latter degenerating into a commercial man, and the exigencies of modern competition tend to foster a purely business view of every new scheme.

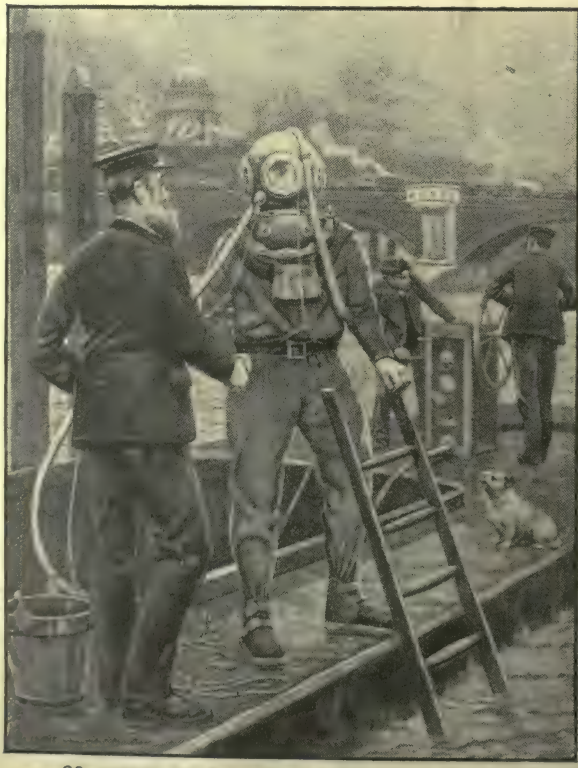


18. ROCK CUTTER



19. LOBNITZ ROCK CUTTER, USED IN MANCHESTER SHIP CANAL

What is an Engineer? In the early days of railway engineering, or about the period extending from the years 1830 to 1850, almost any man who could hold a staff or drag a chain could get employment as an engineer. The work was rough and ready, but sufficient for the purpose; the rolling stock was light and the speed slow, station roofs were an unnecessary luxury; with a few notable exceptions, bridges were of small span and easily constructed, and engineers' calculations were of the simplest. Now the engineer must be scientifically trained, must spend several years in acquiring the requisite theoretical knowledge before he can enter upon the practical study of his profession, and must exercise the highest degree of skill for a remuneration that represents only a small interest upon his outlay. The contractors in those days were, almost without exception, men who had risen from the ranks as gangers and foremen. Money came in freely and many fortunes were made. The contractor must now be a capitalist to start with, and he is fortunate if he does not finish with less than he had at the commencement. It is the province of the social philosopher rather than the engineer to account for all this, but it is interesting to note the facts.



20. DIVER READY FOR ENTERING THE WATER

Continued

ROME AT ITS HEIGHT

The Augustan Age. Tiberius Cæsar. Persecution of the Christians. Sejanus. The Rule of Caius Cæsar. Rome under Caligula

Continued from page 1672

By JUSTIN McCARTHY

THE reign of Augustus would certainly have made its abiding mark on civilisation were it only for the encouragement which it gave to letters and arts. The Augustan age designates an era in literature, and the modern world has frequently applied the phrase to any epoch which has made itself illustrious by its writings. It is applied in England to the reign of Elizabeth and to that of Anne; in France to the reign of Louis XIV., and to other periods in different modern countries. Augustus was a lover of literature, and favoured its culture by every personal encouragement. He was the patron of poets, historians, and scholars, and of painters and sculptors as well. Virgil, the greatest of all the Roman epic poets, was one of the ornaments of the reign. Horace is famous as the author of lyrical and of satirical poems unsurpassed in any literature. Ovid, Tibullus, Propertius, and others, have written poems which form part of the reading of every cultured man. Livy is one of the most picturesque, fascinating, and philosophical historians of any era.

A Patron of Literature. Augustus made the culture of arts and letters fashionable in Rome. He probably inherited some of his love for art and letters from Julius Cæsar, and, although he had not Cæsar's capacity for writing books, any more than for making great speeches, yet he accomplished as much as even Cæsar could have done for the promotion of authorship. He set the example, and it soon became the fashion for the Patrician youth of Rome, and for all who desired to be ranked among the higher orders, to study the great poets and historians, to profess admiration for them, and to quote from their works. During the long period of comparative peace which prevailed while Augustus reigned, there was ample opportunity for young men to think of something besides soldiering, besides camps and invasions, and it was held to the credit of a youth that he took more delight in the reading of books than in the use of weapons.

The Augustan Age. A whole society of wits and humorists, makers of verses and writers of essays, flourished under the influence and the patronage of the Court, and Rome seemed like another Athens in its best days. The spread of culture was then due more to the direct influence of the Sovereign than has been the case in later times, when a ruler has been called the founder of an Augustan age. In some of these later instances, the great poets, romancists and historians obeyed their instincts without special encouragement on the part of the Sovereign and the Court, and the age became Augustan because there were men and women then living qualified to make an Augustan age, and not because there was a leader to encourage their aspirations.

Reforms of Augustus. Augustus was, above all things, a practical reformer. One of his earliest reforms was the establishment of a census, alike of individuals and of property. He introduced a new principle of finance and taxation; he based his taxing system mainly on the land and the personal possessions of the citizens, and he abolished a large number of unequal and capricious imposts which bore heavily on the poor. The financial accounts of the State were kept with strict accuracy, and he introduced the practice of framing what would now be called an annual State Budget. He appointed the governors of all the State provinces, and he personally arranged that the taxation of each province was fairly imposed, and properly accounted for. He took an interest in the affairs of the different municipalities, and he established a police force to keep good order in the towns. He developed, as far as possible, that system of municipal government which began in the Roman states under the guidance of Julius Cæsar.

The population of Rome amounted, during Augustus's reign, to considerably more than a million, and of these a large number were miserably poor. Augustus turned his attention to the removal of the causes which had helped to create that pauperism, and tried to give every man the best opportunity of benefiting by his labour, and to establish a civic equality among classes. The especial gift which Nature had bestowed upon him was the gift of administration. He had little or no genius for war, or ambition for conquest. If he did not inherit any of Julius Cæsar's marvellous capacity for war, he inherited much of his ability for civil administration.

Frontier Wars. During some of the later years of Augustus's reign, disturbances arose on the frontiers, which compelled him for the time to turn his attention from that system of domestic government which he loved and understood to the military work of a Roman ruler. There were frequent disputes going on as to the frontier lines of this or that outlying Roman province. New states forming themselves in Europe were becoming daily stronger, and were organising armies for the recovery of territory which they believed to be theirs by right. In one of these struggles an event occurred which forced some words of deep emotion from Augustus, words which are preserved in history and literature. There was a movement made in the north-west of Germany to shake off the power of Rome. A Roman force, led by a general named Varus, was sent to subdue this uprising; but the

Roman legions had been skilfully drawn into an ambush by the enemy and were cut to pieces, Varus himself being among the first to meet with death. The news of this great mishap brought consternation into Rome, and Augustus cried out with tears the words, "Varus, Varus, give me back my legions!" Germanicus, who afterwards won celebrity, was sent out in command of the Roman force then stationed on the left bank of the Rhine, and succeeded in restoring victory to Rome. Augustus was greatly saddened by these events, for he regarded this outbreak of war as a cruel interruption to the peaceful glories of his later years. He determined for the future to make the Rhine the frontier of his Empire in that region, and thus to avoid the dangers arising from an effort to establish Roman rule over undetermined regions, and to leave his injunction to his successors that they should act upon this principle.

The End of a Notable Reign. Augustus lived for some five years after the events narrated. The wars which occurred during his reign were, for the most part, undertaken to maintain those lines of frontier in foreign regions which his predecessors had laid down. He had no ambition to extend the outlying territories of Rome, and he was willing to make concessions which accepted some obvious line of natural demarcation, such as a great river like the Rhine, for the mark and the limit of Roman rule. Augustus died at the close of August in 14 A.D. at the age of seventy-six. He had ruled over Rome for more than forty years, and his reign was the happiest and the most prosperous that Rome had known or was to know for many generations. He had married three times, but left no son to succeed him. His first wife left him a daughter, Julia, who, after the death of her first husband, married Marcus Agrippa, who died in 12 A.D Augustus adopted two of her sons by this marriage, the elder to be his successor to the throne. Both these sons died in their youth, and Augustus saw no better way of securing the succession than by designating Tiberius, the son of his last wife, Livia, by her former husband.

Tiberius Cæsar. The young man whom Augustus adopted as his heir, and compelled to marry his daughter Julia, bore the names Tiberius Claudius Nero Cæsar. The marriage was not a happy one. Tiberius had served under Augustus in several military commands, and had the reputation of being highly educated and capable. It was not because of any especial leaning towards Tiberius on account of his promising qualities that Augustus had determined to make him his successor. There was an embarrassing vacancy in the succession, and Augustus probably found that he could do nothing better than nominate for the Imperial position one who had a family connection with the house of Cæsar. To call into the Imperial circle an outsider, whatever his gifts, might have seemed too bold a step on the part of the Imperial ruler, and therefore the luck fell upon Tiberius. A familiar saying tells us that there is but one step from the sublime to the ridiculous. There were two steps from Julius Cæsar to Tiberius.

The Birth of Christ. In the meantime, during the Empire of Augustus, an event had occurred in a distant province of Rome which brought on the world the greatest change it has ever known in its history. That event was the birth of Christ and the founding of the Christian religion. It is no part of our task to attempt in this course a detailed record of the events which are told in sacred volumes, are represented in the creed of Christianity, and have opened a new hope and faith for civilisation. Our purpose is to tell the story of the Roman Empire. The tragedy which was enacted in Jerusalem was enacted, indeed, under the authority of the Imperial Government, but that Imperial Government and the Roman people took little interest in the rise of the Christian movement and in the steps taken by the authorities in Palestine to resist its influence. Many years later, Tacitus, the Roman historian, gave it as his opinion that although there might be much to condemn in the creed of Christianity, there had been much undue severity exercised in Palestine with the object of suppressing it. This manner of treating the subject only shows how entirely absent from the great historian's mind was any conception of the sublime influence which the events in Palestine were destined to have over the life of the human race.

Persecution of Christians. The spirit and the influence of Christianity soon spread over the dominions of Rome, and the Roman rulers resisted the invasion of the Christian religion with as much ferocity as they could have shown towards the invasion of some foreign enemy. The martyrdom of Christians soon came to be an event of every-day occurrence in the life of Rome, and the death and torture of the martyr were often made part of the spectacular entertainments for the crowd in a Roman amphitheatre. Not to many of those who gazed upon such sights did the idea occur that the tortures inflicted on the early Christian martyrs were awakening a new spirit of martyrdom, and that the blood of the martyr was already becoming the seed of the Christian Church. Even in Rome the minds of some among those utterly indifferent to such questionings before were beginning to ask what could be the real meaning and spirit of a faith which thus aroused human beings to make themselves the voluntary victims of such sufferings for the sake of the new religion?

More and more as the days went on this noble spirit of inquiry was bringing those who followed it to a recognition of the fact that the world was then ready for the birth of a new faith which should liberate mankind from the sway of those divinities created by human superstitions, divinities that, when they represented power at all, represented for the most part the power of Imperial selfishness and the passions of men. The time had outgrown the gods and goddesses of a distant day. Literature of an advanced order took as little account of the old-world deities as the early literature of a

more modern day would have taken of the fairies and hobgoblins whom it was pleasant to meet in fanciful poems and in grim ghost stories. Jupiter and Juno, Mars and Venus were to such men as Virgil and Horace no more realities than the "Faërie Queene" was to Edmund Spenser. The worship of the old gods had in that sense been completely put aside, and the faith and intellect of what was then civilisation were only waiting for a fresh and a full revelation of the truth. The growth of Christianity soon made itself apparent in other regions as well as in the dominions of Rome, and it was not long before the Apostles began to proclaim their mission, and to have their devoted disciples ready to follow them to any sacrifice for the promulgation of their creed.

The Reign of Tiberius. Tiberius had now, 14 A.D., begun his reign. He appears to have entered upon his dominion in a manner intended to impress his subjects with a belief in his mildness, intelligence, and justice. He had, in his earlier days, been accused of conduct, alike in his public and private life, which suggested cruelty and immorality, but he desired at the opening of his reign to present himself in a new character to his people. He declined to receive some of the extravagant demonstrations and honours offered to him by the over-loyal Senate. He had been invited to sanction the raising of temples to his glory and in his name, but he told his enthusiastic admirers that he only came to them as a man, and did not claim to be worshipped as a god. If he did not actually diminish the taxation imposed upon the country, he did not encourage any attempt to have it increased, and he endeavoured to find suitable men to hold office as governors of the various provinces. Some of his military commanders were able men, and had won much public honour. One of them, Germanicus, who had already won distinction under Augustus, was very popular among the Roman citizens.

Germanicus, who was a nephew of Tiberius, and belonged to the Cæsar family, was adopted by Tiberius. Under his leadership he had, during the reign of Augustus, won victories, which for the time appeared decisive, over the whole German country between the Rhine and the Elbe. Like others of the Cæsar family, he had a certain literary gift, and he wrote some books and composed some poems which were highly thought of.

Jealousy of Germanicus. Tiberius soon began to show his real character. In the ever-growing jealousy of Germanicus, because of the popularity and the great position which the distinguished soldier had already won, he recalled him from his most important commands, sent him into the Syrian provinces, and, according to the authority of trustworthy historians, sent emissaries of his own there with instructions to thwart Germanicus secretly in his projects. Germanicus, while still a young man, died in Syria, and there was a strong belief among his friends that he had died of poison, and also a shrewd suspicion that the poison had been administered by one of the agents of Tiberius. Even before this time Tiberius had committed many acts of private vice and public oppression. For some years of his reign he did not allow his real inclinations and his love of arbitrary power to show themselves in his public acts; but an event in his life brought about a complete change in his conduct as a ruler. His son Drusus, to whom he was devotedly attached, was in his confidence, and exercised a wholesome influence over his conduct. But Drusus had a rival in the counsels of his father.

Rivalry of Sejanus. This rival was Sejanus, Commander of the Prætorian guards, a man of immense ambition, unscrupulous character, and great persuasive power. Sejanus won more and more control over Tiberius, but he found Drusus a dangerous rival in his way. The impression of historians is that Sejanus aimed at nothing short of the control of the State, and that he even hoped to obtain, by some means, the position of Emperor. Drusus died suddenly in 23 A.D., and it was firmly believed by many at the time, and the belief has found recognition in history, that Drusus was done to death by poison through a secret plot of Sejanus. The death of Drusus left the Emperor wholly in the hands of Sejanus, who for a time played the part of an absolute tyrant. This was the more easy for him because, after the death of his son, Tiberius, who always disliked the work of governing and felt out of his element in the life of Rome, became possessed with a desire to change his atmosphere. He withdrew to an island in the Bay of Naples, where he shut himself up in seclusion, so far, at least, as consultation with Rome was concerned, and left Sejanus free to rule over Rome as he thought fit. Sejanus did his best to make himself popular with the Imperial troops, and banished or put to death any who openly opposed his machinations.

Tiberius in Retirement. The news of these events began to reach the ears of Tiberius, even in his life of secluded sensuality, and at last it became apparent to him that he must take steps if he would prevent the throne from being seized by Sejanus. So long as he believed Sejanus to be acting merely in the interests of his Imperial master, Tiberius, although he knew that some of his own supporters, even some members of his own family, had been made the victims of merciless cruelty, had taken no steps to assert his authority. He was easily made to believe that all these victims had been plotting against him. He had developed that state of mind which made him see a secret enemy wherever he turned his eyes, even among his own family. He seemed possessed by a demoniac combination of panic and anger, and wherever he felt suspicion he made the suspected man the object of his merciless vengeance. He did not return to Rome to find out whether there were any foundation for the reports made to him by Sejanus. In his island home he persistently remained, employing Sejanus as his messenger to Rome to report him the result of the inquiries.

He was now in his seventieth year, and the longer he lived the more tyrannical he became. He believed every story told to him by Sejanus, and was thus readily prevailed upon to suspect his own relatives of plotting his death in order to share his inheritance. The widow of Germanicus, who was described as one of his chief enemies, was, by his orders, sent into a sort of penal colony, where, some years later, she was allowed to die of starvation. Two of her sons were flung into prison—one of them was either put to death or committed suicide, while another was left to perish, like his mother, of starvation. The third son was allowed to live, because he was a mere child. All those of the family of Germanicus whom Sejanus feared because of his ambitious schemes, or Tiberius because of his personal safety, were thus put to death.

Downfall of Sejanus. Then Sejanus took a step which brought the whole fabric of his ambition to the ground. He asked Tiberius that he might be allowed to marry the widow of Drusus, son of Germanicus. This request was, under the conditions of the newly-formed Empire, much the same as if he had asked to be named the successor to Tiberius. It came as a flash of light upon the mind of Tiberius, dazed by sensual excess, by cruelty, and by fears, and that light revealed to him, for the first time, the character of Sejanus. He refused the audacious request. But he did more than that. He became convinced that Sejanus would make the refusal an occasion for plots against himself, and when the former returned to Rome, Tiberius sent his orders to the Senate for his arrest. That assembly ordered a trial, which ended in his conviction of treason against the Empire, and a sentence of death was immediately carried out.

Sejanus had long been hated by the Roman people, and they manifested their feelings by tearing his dead body to pieces in the streets and flinging the remains into the Tiber. The fury of the people rose so high that, before it could be stilled, the son and daughter, and some of the close friends of Sejanus, were put to death. The whirligig of time brought about its revenges, and the deaths inflicted by Sejanus had brought a like fate to himself and to some of his kindred.

Rome Torn by Factions. During the remainder of the Emperor's life Rome was the scene of incessant disturbances, brought about by the rivalries of factions and the plottings of political parties, each ambitious to place its own leader or favourite on the throne soon to be vacant. During his closing days, the mind of Tiberius completely gave way. His nerves were utterly broken down, and he appeared to be threatened with insanity. His frame was exhausted by years of sensuality, and he died on the 16th of March, 37 A.D. It is believed that he was suffocated by Macro, the Prefect of the Prætorian guards, the successor of Sejanus in the confidence of Tiberius. Thus closed one of the most sickening stories which even the worst days of the Roman Empire can tell.

The successor to Tiberius was named Caius Cæsar; he belonged to the Imperial family, but will ever be known to history as Caligula, although that was but a nickname given to him by the legions with whom he served in his boyhood, from the fact that he wore very small *caligæ*, or military boots. This ridiculous epithet is now universally accepted, even in the gravest histories, as the name of the fourth Roman Emperor, and is much the same as if a modern sovereign were to be known by the name of Bootikins.

A Chaotic Reign. Not long after he became Emperor he was seized with a severe illness which unsettled his reason, and this is, perhaps, the only explanation of the acts he perpetrated during the remainder of his career. His reign had begun in general hopefulness, and as the descendant of Germanicus he was welcomed with the greatest enthusiasm by the soldiers and the people. Until this malady came upon him he appeared likely to do well as a ruler; but with that change all was altered for him and for those he ruled. He gave up much of his time to gambling, and when he lost vast sums of money he extorted all that he wanted from this or that province or town, and put to death any leading men who endeavoured to resist his demands. He erected a temple to his own honour, declared that he must be worshipped as a divinity, and that he had come to make war upon and to extinguish the old gods of his forefathers. He squandered in less than a year the immense treasure accumulated by Tiberius, and he made the amount of his expenditure one of his boasts; he entered Gaul at the head of his troops, and plundered that province as if he were some robber chief.

Caligula Executed. He once amused himself by constructing a bridge of boats across an arm of the sea about three miles wide, covering it with earth, and erecting houses on it. The work being done to his satisfaction, he gave a banquet in the middle of the bridge, and crowned his joy by having numbers of his guests thrown into the sea and drowned. The Roman people became weary at last of this wretched madman, and soon after his return to the capital from one of his expeditions into Gaul a movement was got up against him by the leader of a Prætorian cohort and other men of influence, and he was murdered, or it might be more properly said, he was tried, found guilty, and put to death. The popular feeling was so strong against him that his uproused enemies were not content with the execution of the tyrant, but his wife and his daughter, who were believed to have encouraged him in his crimes, were made to share in the vengeance, and like him, were made victims of a death sentence. There was no civil organisation in Rome at that time which could have rescued the State and the man himself from such a series of calamities. The struggle of rival parties was too keen to allow the Senate and the Tribunes, even if they had been ready for such a work, to resolve that a raging lunatic must not be left to rule a great Empire, and then to place the madman in seclusion under humane control.

Continued

STRUCTURAL MECHANICS

Matter, Force, and Motion. Pressures and Reactions. Specification of a Force. Triangle and Parallelogram of Forces. Parallel Forces. Moments. Couples

Continued from page 1704

By Professor HENRY ADAMS

Matter and Force. All material substances may be classed under the general term *matter*, but it is very difficult to give a definition of matter. It has been described as the element of resistance in the sensible world, and again it is that which is the subject of motion, or upon which force can act; while force has been defined as that which produces or destroys motion, or which tends to produce or destroy it, or which alters or tends to alter its direction. Force and matter are so intimately related that they are inconceivable apart and necessarily involve the conception of space and time. Fortunately it is not necessary to comprehend the ultimate reality of things in order to understand the laws by which Nature works and to be able to utilise them in producing the desired results.

Pressures and Reactions. If only one force act upon a body, motion must ensue, but two or more forces may be in equilibrium and the body is then at rest. Forces at rest are usually called pressures or reactions; for instance, a pound weight resting on a table produces a pressure by the attraction of gravitation, and the table resists this or reacts upwards with an equal pressure. The pressure of the weight may be called an active force, and the reaction of the table may be called a passive force; they are both real forces although no movement takes place. If a block of indiarubber were interposed it would be seen to be compressed, and this compression would perhaps be more clearly comprehended as tending to move the weight upwards with exactly the same force as gravity pulls it down.

Statics is the science of forces in equilibrium or pressures, which must be understood as free to move, but remaining at rest because they are balanced. The graphic delineation of forces, or their representation upon paper, is of the utmost practical importance and helps very considerably to reduce the labour of the engineer in calculating the stability of his structures.

Specification of a Force. Forces may be represented graphically by straight lines, whose position upon the paper gives their line of action or *direction*; the length of each line to any given scale represents the *magnitude* of the force; an arrow-head placed anywhere upon the line gives its *sense*, or the direction in which it presses; and if a force acts upon a body the point at which it touches is called the *point of application*. For example, **108** shows a body (A) acted upon by the forces which may or may not balance each other, as tests to be applied presently may determine.

Parallelogram of Forces. It is a law of mechanics that each force produces its own result so that if, in **109**, force 1 would in a given time cause a body at A to travel to B, and force 2 would in an equal interval of time cause a body at A to travel to D, the two forces acting together would carry the body from A to C, that is, it travels north a distance equal to AB by the action of force 1 and travels west a distance equal to AD by the action of force 2. This is the foundation of the parallelogram of forces, and it is self-evident that the two forces may be replaced by a third one, marked 3, which forms the diagonal of a parallelogram two of whose sides are formed by the other two forces. Then force 3 is called the resultant of forces 1 and 2, or forces 1 and 2 are compounded into the one force 3 which will produce identical effects. The line AC, which is equal and opposite to the resultant, is called the equilibrant because it exactly balances the other two forces or their resultant. It will be seen that the arrow-head should be placed upon the resultant in the same direction as upon the two forces it replaces, but upon the equilibrant AC the arrow should point in the opposite direction—*i.e.*, opposed to the resultant.

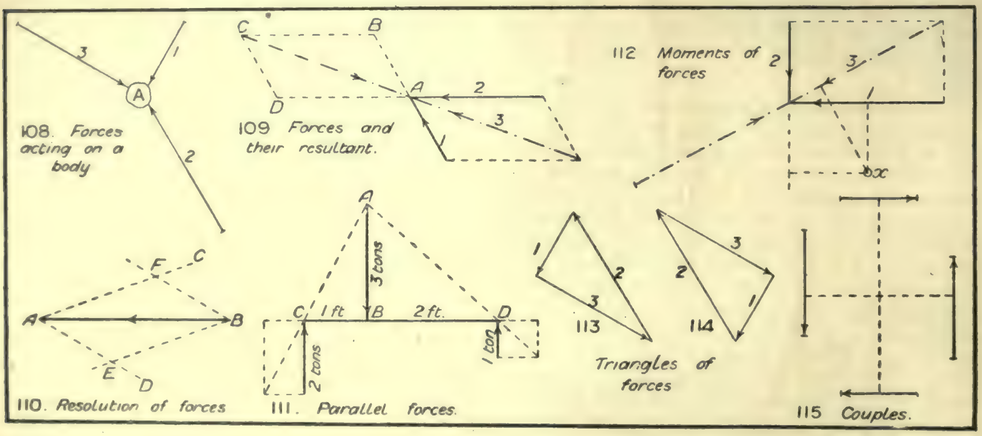
Resolution of Forces. In a somewhat similar manner a single force, as force 3 in **109**, may be resolved into two other forces such as 1 and 2, but whereas two given forces have only one resultant, a single force may be resolved into an infinite number of other forces acting in an infinite number of directions. Generally, the required directions are given and sometimes one of the required forces. If it were desired to resolve force AB [**110**] into two forces in the direction AC AD, from point B draw a line parallel to AC to cut AD in E and also a line parallel to AD to cut AC in F as shown, then force AB might be replaced by forces AE and AF acting towards A.

Parallel Forces. When a force A [**111**] is acting at point B against an extended body CD, and is to be resisted by parallel forces acting at C and D, the force at C, multiplied by the distance CB, must be equal to the force at D multiplied by the distance DB, and also the sum of the two forces acting at C and D must equal the force AB. These forces may be found by calculation or by graphic construction. It is a question of leverage. Force A multiplied by the lever arm BD and divided by the lever arm DC will give the magnitude of the force at C, and vice versâ. The force A multiplied by the lever arm BC and divided by the lever arm CD will give the magnitude of the force at D. If the system be drawn to scale, and a force of unit value be added beyond C and D, and

indefinite lines be drawn from the extremities parallel to A, then lines drawn from the end of A, through C and D, will cut off the last lines at a length equal to the required forces at C and D, as shown. If A be looked upon as a force, and C and D as reactions, then we may say that the sum of the reactions must equal the magnitude of the force, and the moments of the reactions must be equal to each other. A *moment* is the brief expression of a *force or reaction multiplied by a leverage*, so that if the force be in pounds and the leverage in feet, the moment will be in pound-feet. The expression is used in this form to distinguish it from foot-pounds, which is the form for units of mechanical work in dynamics.

Moments of Forces. A moment being the product of a force into a leverage, the moment of force 1 in **112** about point x will be the magnitude of force 1 multiplied by its perpendicular distance to x. In a similar manner the moment of force 2 about x will be the magnitude of force 2 multiplied by its perpendicular distance to x, but in this case the triangular shape would disappear, because two of the sides would coincide exactly with the third side. It is important, however, to look upon it still as a three-sided figure, and it may be called a triangle in the sense that a straight line is the arc of a circle of infinite radius. The reason for taking this view will be seen when reciprocal diagrams come under consideration.

Couples. When two equal parallel forces act in opposite directions, but not in the same straight line, they tend to rotate the body upon which they act with an energy equal to their moment, which in this case is the magnitude of one force multiplied by the perpendicular distance between them. They can only be balanced by two other forces [**115**] having an equal moment, but tending to cause rotation in the opposite direction. Thus the forces of the balancing couple may be equal to the original forces, or smaller or larger, and their distance apart will then be equal to or greater or less than the original distance in order to give



108. Forces acting on a body
109 Forces and their resultant.
112 Moments of forces
110. Resolution of forces
111. Parallel forces.
113, 114 Triangles of forces
115 Couples.

the direction of the force must be produced in order to mark the actual perpendicular. The parallelogram being completed, the moment of the resultant 3 about point x will be equal to the sum of the moments of 1 and 2, and will tend to rotate the system in the same positive direction—*viz.*, anti-clockwise. The moment of the equilibrant about point x will have the same numerical value, but, in order to be an equilibrant, must tend to rotate the system in the opposite or negative direction, or clockwise, round point x.

Triangle of Forces. Turning again to **108**, if the forces are in equilibrium, we may remove them from their present position and place them in the form of a triangle, taking them in any order, but keeping them parallel to their present direction and making their *senses* to run consecutively round the triangle, as in **113** or **114**; if they did not form a perfect triangle, it would show that they were not in equilibrium. Any number of forces may be taken in the same way—even the parallel forces in **111** may be put together in this way; but the same product as before. A couple need not consist of two single forces, but may be composed of two groups of forces, each having a mean centre of effort, at which the sum of the group may be supposed to act. This will be illustrated in the next lesson in connection with the strength of beams.

Centre of Gravity. The centre of gravity has been variously defined; the simplest definition as regards its application to the parts of structures is "that point about which, if the body could be supported, it would be evenly balanced." It is also "that point at which, if the whole mass could be collected, the equilibrium would remain unchanged."

It is sometimes of assistance to make use of the centre of gravity of a load upon a beam, as when the load is distributed over a portion of the length at unequal distances from the abutments, the load upon each abutment, or the amount of reaction at the supports, will be the same as if the whole of the load were collected at its centre of gravity.

Continued

COUNTRIES DRAINED BY THE RHINE

Continued from page 1684

Industries of Belgium. Course of the Rhine in Holland, Germany, and Switzerland. The Alps. Peaks and Passes. Industrial Resources of Switzerland

By Dr. A. J. HERBERTSON and F. D. HERBERTSON, B.A.

Belgium—A Little France. Belgium (11,500 sq. miles) is a small country, only half as large again as Wales. Geographically, it is a continuation of Northern France, the flat surface being represented by the Plain of Flanders in the north, while in the south the land rises to the forested Ardennes. The rivers are the sluggish Scheldt and its tributary the Lys, and the swift, picturesque Meuse, coming down from the plateau of Langres in a forested gorge through the Ardennes, before it crosses the plain to the delta of the Rhine, which it enters, as does the Scheldt.

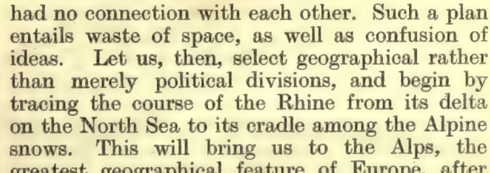
How the People Live. Though so small, Belgium is densely populated. In the plain the whole country is highly tilled, and looks like a vast market garden, unbroken by wall or hedge. Farms and cottages are built on every spot which can be used without reducing the area under cultivation. New land is drained in the marshes or cleared in the forests to supply the needs of the growing population. Enormous quantities of vegetables are grown, as well as rye, oats, wheat, potatoes, and sugar-beet.

Belgian Industries. The industries are equally important [83]. In Southern Belgium many manufactures flourish on the coalfield, which is continuous with that of Northern France. Iron is also abundant. Iron industries of all descriptions, including machinery, locomotives, and all requisites of modern engineering, are carried on extensively in and around Charleroi on the Sambre and Liège on the Meuse. The latter makes firearms of all descriptions, and may be called the Birmingham of Belgium. The woollen manufacture, partly due to the excellent wool of the Ardennes, has been important for centuries. The Leeds of Belgium is Verviers, east of Liège, where glass is also made. Brussels carpets are made at Tournai and elsewhere. In Northern Belgium the chief manufacturing city is Ghent, on the Lys, the Manchester of Belgium. It obtains raw cotton through Antwerp, on the Scheldt, the Belgian Liverpool, and the water of the Lys has remarkable bleaching properties. The linen manufacture has been important for centuries. Most towns make lace, especially Brussels, Ghent, and Mechlin.

A Word on Belgian Towns. Brussels, the capital, on a tributary of the Scheldt, is a pleasing city, with modern suburbs. Its grand cathedral, town hall (Hotel de Ville), and picturesque market-place, surrounded by fine old houses, recalls the ancient splendours of the Flemish cities, which, in the Middle Ages, were the busiest manufacturing and trading centres of Northern Europe. Hardly one of the many Flemish cities, now decayed, but has fine specimens of the domestic and public architecture of the Middle Ages. Even Antwerp, with its great docks, enormous commerce, and all that makes up a modern port of the first rank, its broad streets, and modern conveniences, its sugar-refining, distilling, shipbuilding, and other industries, preserves in its midst the mediæval city which attracts thousands of tourists annually. Ostend is the largest of Belgian watering-places, and an important packet station, especially for Dover.

CENTRAL EUROPE

A Difficult Task. So far we have described regions with a geographical as well as a political individuality; but in Central Europe, as any map shows, the boundaries of the countries do not correspond with any geographical features. The delta of the Rhine, for example, forms Holland, but the rest of its course is in Germany and Switzerland. Or, again, take the Alps. Following a political classification, we must describe the Alps of France, Switzerland, Austria, and Italy separately, as though they



83. THE INDUSTRIAL FIELD OF BELGIUM

had no connection with each other. Such a plan entails waste of space, as well as confusion of ideas. Let us, then, select geographical rather than merely political divisions, and begin by tracing the course of the Rhine from its delta on the North Sea to its cradle among the Alpine snows. This will bring us to the Alps, the greatest geographical feature of Europe, after which we can continue the description of the various other divisions.

The Rhine and Central Europe. Let us, in imagination, stand on a commanding peak in the Swiss Alps and try to realise our position. We are, as it were, on the gable roof of Europe, with the land falling away in all directions to the surrounding seas. Looking north on a clear day, we see, beyond the world of snow-peak and glacier in the immediate foreground, low, rounded hills, forested—if we saw them nearer—showing as a faint blue line on the distant horizon. These are not Alps, but part of the Central Highlands which stretch irregularly across Central Europe under various names, and with many breaks, at the base of the

Alps. Beyond this blue line of hills, if vision permitted, we should see the land gradually sinking to a vast plain, broken by outliers of the Central Highlands, and ending at last in the flat, marshy shores of the North and Baltic Seas. Across this plain we should trace the silver threads of many rivers, following the slope of the land northward to these seas. But of all these rivers, one, and only one, would be the child of the glacier streams sparkling in the Alpine valleys actually beneath our eyes. This river, the one link between the Alpine snows and the seas of Northern Europe, would be the Rhine.

Entering the Mouth of the Rhine. Much of Holland consists of the delta of the Rhine [84]. The land along the North Sea is so low that the sea must be kept out by dykes, and so waterlogged that it must be drained by canals and pumped dry by windmills. Windmills and more windmills, canals, white houses, and green meadows are every traveller's first impressions of the Rhine and Holland. Of course, the sea has devoured great slices of such a coast, forming the shallow gulf of the Zuider Zee, and leaving a chain of sandy islands parallel to the coast. Across this flat region, which is largely made of sediment brought down by the river, the Rhine reaches the sea by many branches or distributaries, forming an intricate network of intersecting channels. We might, therefore, reach the main stream by many routes, from either the North or the Zuider Zee. The usual route is by the Hook of Holland and Rotterdam, on the Lek. At its delta the Rhine receives the Meuse, or Maas, from the hills of Lorraine, rising not far from the French Marne. It is hard to say whether the Belgian Scheldt from the Ardennes and the hills of Northern France, which enters what we may call the gulf of the Rhine, with innumerable islands and sandbanks, is or is not a tributary, but it must not be mistaken for a distributary. Flushing, on the island of Walcheren at its mouth, is where the pilot comes on board for the intricate navigation of the Scheldt to Antwerp, the port of the Scheldt.

Holland, or the Netherlands. Holland (12,600 sq. miles) is an almost treeless, alluvial land, destitute of minerals or building stone, but fertile where it can be drained. The climate does not differ much from our own, but is rather wetter. Cereals, hops, and sugar-beet are grown. The polders, or reclaimed meadows, pasture many dairy cattle, and much butter and cheese are exported. In some respects, therefore, it recalls Denmark. The Dutch are great gardeners, famous for their bulbs. Whole fields of them may be seen in flower outside some towns in spring. There are many industries, the raw materials being cheaply brought by water. The chief manufacturing centres—Breda, Tilburg, and Maastricht—are in the south. Rotterdam, the port of the North Sea, and Amsterdam, the port of the Zuider Zee, both manufacture the colonial produce brought to their wharves from the Dutch East Indies. Amsterdam cuts diamonds for all Europe. Many coast towns trade in butter and cheese, and, of course, engage

84. THE DUTCH LOWLANDS

in fishing. The capital, S'Gravenhage, or the Hague, is on the coast. Inland, a little to the north, is the university town of Leyden. The most important inland town is Utrecht, from which the lower part of Holland can be flooded in case of invasion.

The Lower German Rhine [85]. Crossing the German frontier, we find ourselves on the threshold of a busy industrial region. The valley of the Rühr, the river which enters on the east bank where the great river port of Duisburg is built, has a large coalfield, which feeds the textile manufactures of Barmen-Elberfield, and the iron town of Essen, where the famous Krupp guns are made. It also sends coal by water to Krefeld, west of the Rhine, with silk manufactures. To the south is Aachen, or Aix-la-Chapelle, a woollen and cotton town, on a coalfield. Düsseldorf and Köln, or Cologne, the latter with the finest cathedral in the world, are accessible to ocean steamers, and their trade is enormous. So far both banks have been flat and uninteresting, though the regions on both sides are fertile and prosperous.

The Rhine Gorge. At Bonn, above Cologne, we enter the famous gorge cut by the Rhine through the northern part of the Central Highlands, between the Eifel and the Hunsrück on the west, and the Westerwald and Taunus on the east. Mile after mile we sail between mountain walls, each crag crowned by a ruined castle, and the lower slopes terraced for vineyards. At Coblenz, another great river port, the Moselle, from the Vosges, comes in on the west bank in a forested gorge between the Eifel and the Hunsrück. In its basin is the great fortress of Metz, the Saar coalfield with many manufactures, the independent Grand Duchy of Luxemburg,

and the old Roman town of Trier. Nearly opposite the Moselle confluence, on the other bank, comes in the Lahn, flowing in a similar forested gorge between the Westerwald and the Taunus. The Rhine gorge continues to Bingen, where we emerge into undulating country, and soon reach Mainz, at the confluence of the Main. If we could follow up this noble tributary it would take us by the banking city of Frankfurt, the university town of Würzburg, and the picturesque scenery of the Central Highlands, far into the heart of the Franconian Jura. We should certainly want to visit Nürnberg, on a tributary, the finest mediæval city remaining in Europe, and now a busy manufacturing town.

The Plain of the Middle Rhine. But we must follow the main stream across a richly cultivated plain, 20 or 30 miles wide, between the distant wooded Vosges on the west and the still more picturesque Odenwald and Black Forest on the east. At the busy port of Mannheim a glimpse up the Neckar makes us long to visit Heidelberg, on a lofty crag in its forested gorge. The Neckar is formed by many mountain streams, coming down in lovely valleys from the Swabian Jura, which separate the Neckar from the Danube. The chief town in its basin is Stuttgart, the capital of Würtemberg. The main stream of the Rhine continues across a land of cornfields, orchards, and vineyards. Karlsruhe, the capital of Baden, is connected with the Rhine by canal and has large engineering works; Strassburg, with a fine cathedral, is the port for Mülhausen and other cotton towns of the Vosges. Freiburg lies at the entrance of a lovely valley leading into the heart of the Black Forest. We now approach Basel, or Basle, the frontier town of Switzerland, a great centre of trade and railway traffic, about 750 miles from the mouth and 250 miles from the source of the Rhine.

The Rhine in Switzerland. The direction of the river valley now changes, narrowing between the Black Forest on the north and the Jura on the south. Above this it flows in a gorge between the Swiss and Swabian Jura, leading to Lake Constance. Swift tributaries, green with glacier sediment, rush down from the snowy Alps, now seen in the distance. The largest is the Aar, which rises among the highest peaks of the Bernese Alps, flows through Lakes Brienz and Thun, past Bern, the capital, and then northwards between the Alps and Jura, receiving, among many tributaries, the Reuss, from Lake Lucerne, and the Limmat, from Lake Zürich. At Schaffhausen are the Falls of the Rhine, where the river leaps madly down from the higher ground west of Lake Constance. We next reach its exit from that lake, and are but a few miles from the Danube, the great waterway of Western Europe. From a summit between the two we might possibly look down on waters flowing to the North and Black Seas respectively, so that here, in a sense, east and west, north and south, meet. After leaving Lake Constance, with its ring of towns, the valley leads us south, through scenery of increasing wildness. Swift rivers, leaping down 3,000 or 4,000 ft. in 20 or 30 miles, rush to the roaring torrent of the Rhine, whose valley narrows to a wild gorge. At last, 800 miles from the North Sea, our journey ends, at the source either of the Hither or of the Further Rhine, at a height of over 7,000 ft., among the grandest Alpine scenery.

The Alps. We have now reached the heart of the Alps, which stretch across Europe for 700 miles. We generally think of them as in Switzerland, but they extend west into France, east into Austria, north into Germany, and south into Italy.

To describe the scenery of the Alps in words is not easy. It varies greatly in different parts. In the limestone Alps of Austria the peaks and pinnacles are too steep for snow to lie, and they soar into the sky like fantastic obelisks of many-coloured rock. The familiar scenery of the Swiss Alps is something like this: Starting from our centre we climb on foot, or perhaps by rail or coach, up a smiling valley, between mountains clothed with forests of dark pine. Beside the road a swift torrent leaps from rock to rock in cascades of foam. Little villages of wood, with great overhanging roofs to carry the weight of the winter snow, are gay with vines, fruit-trees, and patches of maize. As we go on, the valley becomes more uphill, the mountain walls higher, the villages fewer, and the stream wilder. The bridges which cross it have canopies over them to prevent snow from breaking them down in winter. As we climb, the woods thin out, and their place is taken by steep meadows gay with flowers of every hue. The tinkle of the cow-bells and the little wooden cheese-houses tell us that we are among the high pastures, deserted in winter by man and beast.

An Alpine Glacier. Above the meadows appear walls of rock, and perhaps at the end of the valley a dazzling vision of snow-peak and glacier. The grass ceases, gay to the last with flowers. We are at the edge of the glacier, with its lines of moraine, rocks, and stones, which have fallen from the towering precipices above, clearly marked on its white surface. Most likely its end is hollowed into a glittering blue ice-cave, out of which gushes the stream we have been following. If we would reach the snowy summits, our way lies over the rough surface of the glacier, with its torn and twisted ice, split by deep chasms and crevasses of giddy depth and dazzling blue. The party is roped together, furnished with ice-axes, dark spectacles to dim the glare from the snow, and, above all, with good guides. Silently and cautiously, for a loud noise or a false step may start an avalanche of stones or snow and hurl all to destruction, the climbers make their way over glacier and snow-fields, or along a knife-edge of rock, to the summit, to behold a view no words can describe. They may descend on the Italian side, through similar scenery. The snow and ice will not come so low as on the Swiss side, and in the lower valleys chestnuts will replace pines, and mulberries, vines, figs and other fruit will speak of the Sunny South.

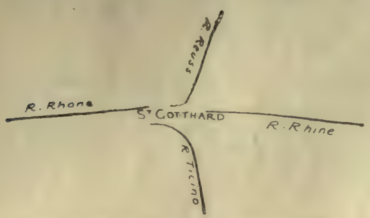
Valleys and Peaks of the Alps. To understand the geography of the Alps, let us first be clear about the famous St. Gotthard region, the cradle of many Alpine rivers. We reach the St. Gotthard Pass, the gate of this region, from Lucerne, by following the lake, and its feeder, the Reuss, up to a height of 7,000 ft. A wonderfully engineered railway follows the valley to a height of 3,800 ft. and then plunges into the bowels of the mountains in a tunnel 9¼ miles long, emerging at the head of the Ticino valley, which leads down to Lake Maggiore, Milan, and the plain of the Po. Only a few miles from the source of these two rivers are those of the Further Rhine, flowing east, and of the Rhone, flowing west, while those of the Aar, in the Bernese Oberland, are also near [86]. Once clear as to these rivers, we can easily fix the geography of the rest of the Alps in our minds. The Rhone flows west in a great trough between the Bernese Oberland to the north and the Pennine Alps to the south. Zermatt, the needle-like Matterhorn (14,700 ft.), Monte Rosa (15,200 ft.) and other giant peaks, are at the end of valleys opening to it from the south. From Martigny, where the Rhone turns north to Lake Geneva, we may visit the highest peak in the Alps, Mont Blanc, over 15,700 ft. South of the Mont Blanc group two rivers must be noted, the Dora Baltea, flowing south-east down to the Po, and the Isère, flowing south-west through the French Alps of Savoy and Dauphiné to the Rhone. Further south the Durance flows to the same river and the Dora Riparia to the Po.

85. THE BASIN OF THE RHINE

The Aar has already been traced from the glaciers of the Finsteraarhorn (14,000 ft.), the highest of the Bernese Alps, to its confluence with the Rhine. Interlaken, between lakes Brienz and Thun, commands a fine view of the Jungfrau, the queen of the Bernese Alps, and is the starting-point for their finest scenery. The courses of the Reuss and Rhine we also know. East of the Rhine is the Vorarlberg district, and south the Engadine, perhaps the finest of all, with peaks 11,000 to 13,000 ft. high. The Inn flows through grand scenery to the Danube, between the Bavarian Alps and the Tyrol, with Innsbruck as its chief centre. From the Tyrol the Adige, or Etsch, flows south, near the Ortler group (12,800 ft.), the highest part of the Austrian Alps, the only one of the many rivers flowing south in long parallel valleys which does not enter the Po. Near the source of the Adige is the Gross Glockner (12,400 ft). The scenery and direction of the valleys gradually change. The rivers no longer flow north and south, but east to the Danube, the largest being the Drave and Save. These eastern Alps form the Austrian provinces of Styria, Carinthia and Carniola. From the northern end of the Austrian Alps spring the forested Carpathians, and from the southern the Dinaric or Dalmatian Alps, which border the eastern shores of the Adriatic. The Apennines of Italy are also an offshoot from the Alps, but with quite different scenery.

Some Notable Alpine Passes. These are, of course, connected with the valleys

already mentioned. In the centre the St. Gotthard leads from the head of the Reuss valley to the head of the Ticino valley, thus giving a through route from the North Sea to the Adriatic. In the west the Mont Cenis, also followed by a railway, with a tunnel 7½ miles long through the core of the Alps, leads from the valley of the Arc, a tributary of the Isère, to that of the Dora Riparia, a tributary of the Po, and to Turin. The Brenner, in the east, leads from the Inn to the Adige. All these give through routes right across the Alps. The Simplon, with a tunnel 12½ miles long, leads from the middle of the upper Rhone valley to the valley of the Toce and Lake Maggiore. Many famous passes, not accessible by rail, lead from one valley to another, but these need not be mentioned.



86. THE ST. GOTTHARD PASS

Switzerland. Switzerland (16,000 sq. miles) is a union of many independent cantons which grew up on both slopes of the Central Alps, round the lakes which fill many of the lower valleys, and on the plateau at their northern base. The Federal capital is Bern, on the Aar. Except on the plateau, the larger towns have become important because they command good routes across the Alps. Zürich, Luzern (Lucerne), Bern, Lausanne, and Geneva are examples.

Climate. On the plateau the climate is that of Central Europe, with hot summers and cold winters. In the Alpine valleys the winter varies in severity with elevation. Winter snow covers the summer pastures, blocks many of the passes, and renders the streets of the higher villages impassable.

Why Switzerland is Prosperous. Switzerland is a brilliant example of what can be done by utilising the national resources, whatever they are. A land of uninhabitable mountains, with hardly any lowlands suited for agriculture, with no coal to feed manufactures, and producing hardly any raw material, it would seem to have small hope of prosperity, yet it is one of the richest countries in Europe. Mountaineers are generally resourceful and energetic, and the Swiss are no exception. They make the most of agriculture on the plateau, their manufactures are flourishing, their dairy industries world-famous, and they have brought to perfection what they call the *Fremden industrie*, or trade in tourists.

The Tourist Industry. Switzerland discovered this industry and makes a fortune by it. Everything is done to develop it. Railways are carried everywhere, even up nearly perpendicular cliffs, and will soon reach the summit of the Jungfrau itself. Well-equipped hotels are built actually at the snow-line. Summer brings its tens of thousands of tourists, who enrich the army of caterers, cooks, waiters, porters, railway servants, and mountain guides who follow in their train. The favourite centres are the Engadine, where Davos is a sanatorium for consumptives, Zermatt, in the Pennine Alps, Interlaken, in the Bernese Oberland, Chamonix, for Mont Blanc, Vevey, and many other towns round the lake of Geneva, and Luzern and smaller towns round that lake for the fine scenery about the St. Gotthard.

Swiss Agriculture. Agriculture is confined to the plateau and the lower valleys, where rye, oats, and potatoes are the chief crops. The summer is hot enough, especially on Lake Geneva, to ripen the vine and maize, and in the valleys of the southern slopes the mulberry and olive are also cultivated. Not enough food is grown for the population, and food-stuffs are largely imported.

The Dairy Industry. With the rich pastures of the Upper Alps, dairy farming was bound to be important. Many Swiss cheeses are famous, and the manufacture of condensed milk is a specially Swiss industry. Notice how the character of a country affects even the way in which it pays to use milk. Other pastoral countries, Ireland, Denmark, Holland, make butter their staple, but they are maritime. Switzerland is in the heart of Europe, and transport is difficult and costly. Cheese and condensed milk are highly portable, and do not spoil by keeping. Hence their selection. Let us never forget to look for geographical explanations of this kind.

Manufactures. The manufactures are important, partly because the people are shrewd, industrious, and well educated, but also because there is an inexhaustible supply of cheap motive power. This is furnished by the irresistible force of the rivers rushing down from the Alps. Always important, water-power has become invaluable with the development of electricity as a motive-power. The electrical industries are growing all over Switzerland.

The mountain railways are driven by electricity, and the nearer a town or hotel is to the snow-line, the more certain is it to be lighted by electricity. Textiles are manufactured in the busy towns of the plateau, silk at Zürich and Basel (Basle), and cotton round Zürich and St. Gallen. Textile and electrical machinery are made at Zürich, the industrial capital of Switzerland, and locomotives at Winterthur. Geneva, the commercial centre of the west, gives its name to the watches and clocks made in the valleys of the Jura, in the canton of Neuchâtel, north of the lake of that name. Lausanne, magnificently situated on the north of Lake Geneva, is also a busy town.

Continued

TAILORING FOR WOMEN

Plain Double-breasted Coat. Tracing the Pattern. Sleeve Drafting. Pressing. Preparing the Fronts. Pockets and Linings

By Mrs. W. H. SMITH and AZÉLINE LEWIS

OF late years the term "tailor-made," as applied to ladies' garments, has included the most elaborate confections, distant as the Poles are asunder from the original ideal—a plain, neat costume, distinguished only by the perfection of its fit and cut.

To a sartorial artist the former are but hybrid productions, and he inclines more to the real "tailor-built" coat or gown, which may be considered the foundation of all good ladies' tailoring.

A Double-breasted Coat. As it would be impossible to deal with all the varieties under this heading, we have selected for our first example a plainly-fitting, double-breasted coat, as that from which the most benefit can be derived, and so pave the way for more elaborate styles.

MATERIALS REQUIRED. 2½ yd. of cloth, 54 to 56 in. wide; 2½ yd. lining, 42 in., or 5 yd. silk, 22 in. wide; ½ yd. linen; ¼ yd. hair cloth; 1¼ yd. linen canvas; 3 in. collar canvas; 1 doz. fancy buttons; a reel of machine silk; buttonhole twist.

All the linings and trimmings required should be procured at a tailors' trimmings warehouse. It is well to have the finest linen canvas and the best fine linen for the stays.

Measurements: Bust, 34 in.; waist, 25 in.; sleeve (centre-back to elbow), 20 in.; elbow to wrist, 10 in.; neck, 15 in.; length of back, 16 in.; full length, 40 in.; front length (nape to waist), 21 in.

The measurements are taken the same as those for DRESSMAKING [see page 186], with the addition of one from the nape of the neck (at back) to the waist in centre-front, which gives "front length." The chest measure is taken 2 in. above the bust-line.

Working scale, half-bust; ¼-in. turnings are allowed on all seams.

The Drafting. A sheet of brown paper will be required, 36 × 48 in. Square lines 5 in. down from top and 4 in. in from long edge; letter the corner A [58]. A to A^a, one-sixth of neck (2½ in.); A^a to A^b, ⅜ in.; A to B, one-sixth of back length (2⅝ in.); A to C, one-third (5⅜ in.); A to D, length of back (16 in.); D to D^a (2½ in.); D to E (7 in.); D to E^a (24 in.), or length required. Square all lines except waist; D to 1 (1¼ in.); draw centre-back line from 1 to A, and from 1 through E line to bottom of coat, E^b. Back line to C^a (on bust-line) one-third of bust plus ⅜ in. (6½ in); on to F, two-thirds (11⅜ in.); F to F^a, one-fourth of bust (4¼ in.); F^b midway between; F^b to X, ⅜ in.; back line to G, half the bust and ½ in.; G to H, 3 in.; C^a to I, one-twelfth (about 1½ in.). Square line up from C^a, make J on B line.

BACK SHOULDER. Slightly curve from J to A^b, and neck from A^b to A. C^a to J^a, half the distance from A to C [see broken line]; make a dot ¼ in. below J^a, and K ¼ in. to the right of dot just made.

Square line from G to neck-line, and make L; L to M, one-sixth of neck (2½ in.); M to M^a, 1¼ in.; M^a to N, one-sixth of neck (2½ in.).

Square a line from N, one-fourth of bust, and make H^a; N to N^a, 1¼ in., or half the distance from N to M^a; curve the neck from H^a through N^a to M^a.

FRONT SHOULDER. Draw line from M^a to J; make O the length of back shoulder less ¼ in.; drop O ¼ in., to take off the sharp angle at that point.

ARMHOLE. Curve from O through F^a and X to I, and from I to K; I to I^a, ¼ in.; M^a to P the front length (21 in.) less the back neck measure, as from A to A^b (2⅞ in.). Draw line from H^a through P, the length of coat make P^a; P^a to P^b (3 in.). Draw waist-line from 1 to P.

SIDE PIECES. F to I^b (1¼ in.); 1 to 2 (2 in.); curve from 2 to J^a; where the curved line crosses bust-line make dot 3; 3 to 4 (⅝ in.); 5 midway between 4 and I^b.

WAIST SUPPRESSION. 2 to 6 (1½ in.); 6 to 7 (½ in. less than 4 to 5); 7 to 8 (1½ in.); 8 to 9 (½ in. less than 5 to I^b); 9 to 10 (1½ in.); drop 6 ½ in. in order to make the curve on side-piece the same length as from 2 to J^a. Curve from 6 through 4 to K from 7 to I, from 8 to I^a, and from 9 and 10 to I^b.

Now carefully measure up the waist—*i.e.*, between 1 and 2, 6 and 7, and 8 and 9; total, 7 in. Deduct the amount for turnings—*i.e.*, 1½ in.—this leaves 5½ in.; place this amount ¼ in. to the right of 10, with the inch-tape resting on P, and make a dot at half the waist measure.

The distance between the dot and P is the amount to be taken out in darts, which in this case is 3 in. P to 11, 2½ in.; 11 to 12, width of first dart (1 in.); 13, in the centre of dart; 12 to 14, 1½ in.; 14 to 15, width of second dart (2 in.); 16 in the centre. Draw lines through the centre of each dart from bust to seat-line parallel with centre-front line. Curve the darts to within 2½ in. of bust-line; extend the centre line of second dart to bottom of coat, and make 17; draw lines from 17 to 14 and 15.

Square lines down from the centre of 9 and 10, and 7 and 8, to the bottom of coat; make dots; 10^a 1 in. to the left of dot, and 9^a 1 in. to the right. Treat the second dart in the

same way, making 7^a and 8^a $\frac{1}{2}$ in. to the right and left of dot. Draw lines from 9^a and 10^a to seat-line, then curve from seat-line through hip-line to 9 and 10; treat the second dart the same; draw line from 2 to the bottom of coat; make 2^a, then 6^a, $1\frac{1}{2}$ in. to the left of 2^a; draw line from 6^a to 6.

THE LAPEL. H to H^b 3 in.; P to R $2\frac{1}{2}$ in.; draw line from H^b through R to bottom of coat, make P^b; extend B line 3 in. from centre-front, make 18; $1\frac{1}{2}$ in. to left make 19; 19 to 20, 3 in.; slightly curve from H^b through 18 to 20. Draw line from 20 to H^a.

THE COLLAR. M^a to S, $\frac{1}{2}$ in.; H^b to T, 2 in.; draw line from T to S; S to T^a, width of back neck as from A to A^b; H^a to 21, 2 in.; 21 to 22, $\frac{1}{4}$ in. Draw line from H^a to 22, and from 22 to T^a; square line down from T^a; T^a to 23, 2 in. for fall; 23 to 24, 1 in. for stand. Where T crosses neck-line make N^b; curve from N^b to 23, and from N^b to 24; and slightly curve from 24 to T^a.

A small dart $\frac{1}{4}$ in. on either side of P, tapering away to nothing above and below waist-line, is a great improvement to the figure. The top of dart should terminate 3 in. from bust-line and bottom $1\frac{1}{2}$ in. below hip-line.

Tracing the Pattern. Place the drafting on another sheet of brown paper. The back should be cut first. Trace from 1 to 2; from E^b through 1 to A; from 2^a through 2 to J^a, on to J, A^b, and A, then E^b to 2^a. Remove the drafting, cut out the back, and replace the drafting on the paper, each piece being cut out in the same way.

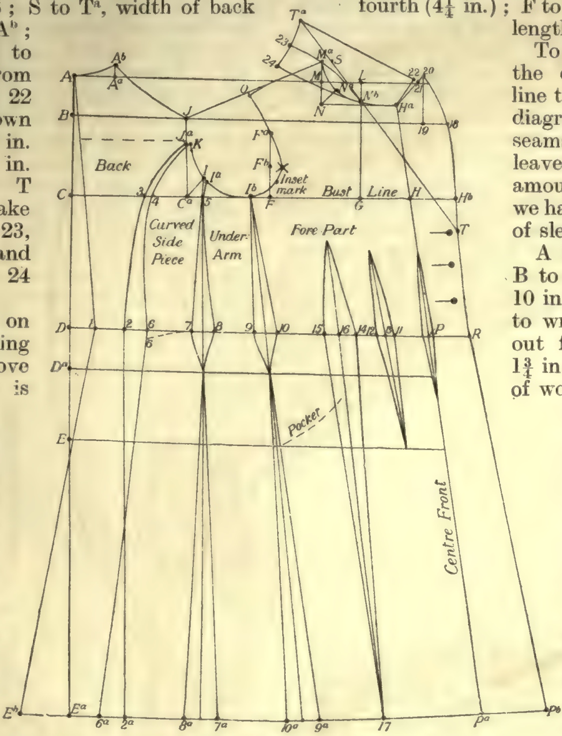
CURVED SIDE PIECE. Trace from 6 to 7; 6^a through 6 to K; from 6^a to 7^a, from 7^a through 7 to I, and on to K.

UNDER-ARM PIECE. Trace 8 to 9; 8^a, through 8 to I^a; from 8^a to 9^a; 9^a through 9 to I^b, on to I^a.

FORE PART. Trace 10 to R; 10^a through 10 to I^b, on through X to O; 10^a through P^a to P^b; centre-front from P^a through P to H^a, on to M^a, thence to O.

THE LAPEL. Trace from P^b through R round the lapel to H^a. Trace the fold of lapel from T to S, also the dot N^b, and the inset mark for sleeve $\frac{3}{4}$ in. above bust on armhole curve. Trace the darts carefully.

THE COLLAR. Trace from H^a through N^b to 24, on to T^a; from N^b to 23; and H^a to 22 on to T^a.



58. COAT DRAFTING

Sleeve Drafting. Working scale, half-bust, 17 in.; $\frac{1}{4}$ in. turnings are allowed on all seams [**59**].

Take a piece of brown paper, 30 by 16 in; 5 in. down from top and 1 in. in from edge, square two lines at right angles; letter the corner A.

A to B, half working scale ($8\frac{1}{2}$ in.); B to C, 2 in.; A to D, half the distance from A to B, less $\frac{1}{4}$ in. (4 in.); D to E, same distance as A to B; F, midway between D and E; F to G, one-fourth of working scale, plus 1 in. ($5\frac{1}{4}$ in.); F to H, one-fourth ($4\frac{1}{4}$ in.); F to F^a, $\frac{3}{4}$ in.; B to I, the length of sleeve to elbow.

To obtain this, measure the distance from back line to J^a [see broken line, diagram **58**]; deduct two seams—*i.e.*, $\frac{1}{2}$ in.; this leaves 6 in. Deduct this amount from the 20, and we have the correct length of sleeve, 14 in.

A to J, 1 in. less than B to I (13 in.); J to K, 10 in. (length from elbow to wrist). Square a line out from K; K to L, $1\frac{3}{4}$ in; L to M, one-third of working scale ($5\frac{3}{4}$ in.); draw wrist-line from L to M, and elbow-line from J to I; J to N, $1\frac{1}{2}$ in.; N to N^a, one-third plus $1\frac{1}{4}$ in. (7 in.)

The wrist and elbow can be made smaller or larger, according to taste and fashion.

Curve from L through N to D; draw line from M through N^a to B, and from N^a to C.

For the top of sleeve, curve from D through H and G to B; and from D through F^a to C; this concludes the sleeve proper.

To obtain a leg-of-mutton shape, proceed as follows: C to C^a one-fourth ($4\frac{1}{4}$ in.); B to B^a the same, plus $\frac{1}{2}$ in.; 1 in. down from B^a make a dot; X is $\frac{1}{2}$ in. to the right of dot. Curve from D, 1 in. to the right of A, through C^a to X.

Tracing the Sleeve. First trace the elbow and wrist lines, then from L through N to D, from M through N^a, X and C^a to D.

Under-part, L to D; M through N^a to C, and from C through F^a to D.

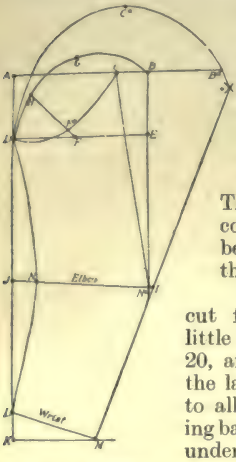
Chalk-marking the Pattern. Lay the various parts on the cloth as in **60**. Should the cloth be faced, they must all go one way (not be reversed). Chalk all round each piece, then chalk the waist-lines, the roll of lapel as from T to S, centre-front as from P^a to H^a,

round all the darts and inset for sleeves. Inlays must be left on the shoulder, top of back-neck, darts, side-seam of fore part, and 1½ in. at the bottom for turn-up; 2 in., or more, on the bottom of sleeve, and ½ in. on the back seam of top part should also be allowed. Chalk-mark the turn-up and cuff.

Thread-mark all inlays, waist-lines, centre-front, lapel roll, darts, neck-curve, turn-up, position of pocket, according to directions already given for Boy's Coat.

The cotton should be two yards in length, doubled and twisted. The twist causes the cotton to grip the material better, and prevents the threads from coming out.

The facings must be cut from the fore part, a little below T, a trifle above 20, and a little wider round the lapel. This is necessary to allow of the latter turning back freely, with the seam underneath. If this is not done, the lapel will curl up instead of under.



59. SLEEVE DRAFTING

The facings must also go 2 in. below M^a on shoulder, and 4 in. from the front at bottom. [See **58** and **60**.] They can be joined, if necessary, to economise material. Should the cloth be firm and not inclined to ravel, the join can be stoated with silk. [See STITCHES.]

Now slightly damp the canvas all over with a wet rag, and press with a fairly hot iron. Fold and cut as in **61**. Shrink the hair-cloth in the same way.

Lining. The lining must now be cut, ½ in. larger and longer than the cloth, the reason being that the latter is elastic, while the former is not. Leave the same amount of inlays, and sufficient for a pleat on the shoulders, and also two in front of armhole—*i.e.*, one at F^a, the other at the inset-mark. This gives plenty of room for the bust, and prevents the lining splitting.

Place each piece with the waist-line running with the thread of cloth, so as to prevent that part being on the bias; if this is not done, the garment will be twisted.

Then, again, the cloth itself is not always creased evenly, so that it is necessary to make sure that the selvedges are together, otherwise it will be found that, whilst one side is cut on the straight, the under-piece is not, which is bound to result in their pulling one against the other, causing what is called a "twist." When this does occur, it is a very difficult matter to put right, so the worker will see it is most important to carry out these instructions for placing before cutting out.

Before proceeding with the making, it is advisable to first read and study the following notes on machining and pressing, as the latter forms a most important part of tailoring, and must be carried out in every detail if the garment is to be a success; moreover, it has to be continually resorted to from the very beginning.

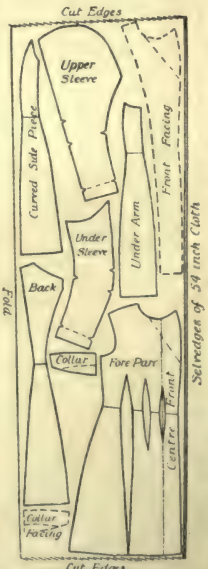
Machining. Before stitching the seams the worker should see that the machine is perfectly clean. If it requires oiling, it should be well worked to allow the oil to get into all the parts.

When this is done, try the stitch on a piece of the same material as the garment. To be perfect it should be locked in the centre, so that it is the same on both sides. Should the thread or cotton lie in a straight line along the back, the tension is too loose, and must be tightened by turning the tension-screw to the right—*i.e.*, towards you. Should it lie across the top, it is too tight, and the screw must be turned to the left. When once the stitch is made right it is advisable to leave it so. It is seldom necessary to alter the foot. Should there be any very thick seams it can be raised a little by the foot lever while working; this will be far better than altering the position of the foot.

Be very careful not to start or leave off machining with a jerk or violent start, as that will soon throw the machine out of order, and take half the service out of it; always loosen the top cotton and draw out both the top and the under together 2 or 3 in. before cutting.

Now as to the cottons, etc. That on the shuttle or bobbin should always be a size coarser than the top, let it be silk, cotton, or thread. In stitching all outside edges great care is needed to do so evenly and to keep the corners square or round, as the case may be. If the former, it will be necessary to come to a stop with the needle at its lowest point. The foot must then be raised and the work turned round, so that the stitching is quite square. If a rounded corner is desired, the lever must be kept up slightly with the left hand, and the machine kept in motion, but worked much slower while the corner is being turned.

The work must, of course, be carefully guided all the while. Care and practice are needed to accomplish good machining.



60. ARRANGING PATTERN ON MATERIAL

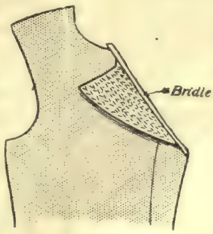
Pressing. The chief object of pressing is to make the seams and inside smooth, and yet to preserve, and in some cases improve, the shape of the different parts of a garment.

The seams of a bodice or coat should be smoothed on each side of seams before pressing them open. If the cloth is thick and heavy damp the edge of seams with a small sponge; this facilitates the opening process.

The iron must not be kept on too long, and must be lifted up to let off the steam generated by pressing ; if kept on too long, the oil in the wool will be drawn by the heat of the iron to the surface of the cloth, which will take a great deal of steaming with a damp cloth to remove, and the cloth would need re-pressing. These remarks apply to all kinds of pressing ; the newer the wool the more oil there is in it, and the greater the care needed in pressing. Care must be taken to preserve the shape and cut of any part of the garment. In sleeves, avoid stretching the elbow.

The seams, when laid on sleeve-board, must be smoothed on both sides, as already explained. Begin to press from the bottom to the top of darts, and gradually smooth the round away on the pressing pad described, taking care not to press to the front nor into the armhole ; this is important to preserve the shape. After the canvas or linen has been put into the coat, stretch out the shoulder seams towards the neck.

Great care is needed here to make the waist fit closely when on. If the figure is very hollow it is best to strain out the hollow in waist-line 1½ in. above and below with the left hand while pressing this portion.

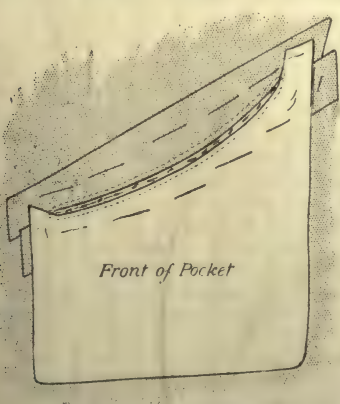


62. PUTTING THE LINEN ON LAPEL

The Pressing Pad. The pressing pad is a most necessary adjunct to the outfit for ladies' tailoring to enable the rounded portion of the figure to be dealt with. It can easily be made as follows :

Cut two oval pieces of cloth, each measuring 11 in. in length and 8 in. across the widest part. Stitch them together to within about 3 in., and pack well with small pieces of cloth till the pad is perfectly hard ; then sew up the opening.

The Making. We can now return to our material. Take the right front, baste the darts from top to bottom, stretching the back parts to meet the front, as at **11**, **12** and **14** and **15** ; they must be stitched from the bottom to a fine point at the top, leaving no blister or bubble. Slightly damp the seams on both sides (if the cloth is thick), and press both sides on a bare board with a moderately hot iron until it is perfectly dry. If this is not done the seam will rise again, and no amount of pressing will flatten it. Slightly



63. THE POCKET

stretch with the left hand 1½ in. above and below waist while pressing ; great care should be exercised here while doing so. The centre-front dart, as at P, must next be basted and stitched, tapering it to very fine points top and bottom. Now open the seams, slightly damp them, and press. The top of darts should be pressed on the pad described, over a clean, damp cloth (which should be folded), to press out all bubbles and give a rounded appearance to the bust. The bottom of centre and first darts must be pressed on a bare board or cloth, the latter for preference.

61. HOW TO PUT IN THE CANVAS

The Canvas. We are now ready for the canvas. First cut the centre-front of dart, and serge the edges together closely to make them lie flat. If the canvas is very thin, as it should be, it can be seamed.

Place the right front on the table wrong side uppermost ; place the canvas in position ½ in. beyond the front of lapel to allow for padding, baste to the cloth, keeping it rather loose, particularly across the chest. Be sure and slit the canvas as in diagram **61**, and insert two wedges of canvas on the shoulder ½ in. wide at the top and 2 in. long, tapering to nothing. These must be secured to the canvas ; then baste the bridle along the break of lapel, as from T to N°. This consists of a strip of straight linen 1 in. wide, folded in half, with the fold placed to that of lapel, which must be held rather tight [**62**].

The Lapel. Pad the lapel to within ½ in. of the edge of cloth (the closer the stitches are the better will be the result) ; on no account must there be any ridges between the rows ; and a fine needle and silk should be used, the silk being drawn up lightly.

Preparing Fronts. When this has been done the canvas must be pared away ¼ in. from the edge of cloth. Now cut the linen stay 1 in. wide and long enough to go from 1½ in. beyond the break of lapel right round front and down to the bottom of coat. When basting it must be held rather tightly 3 in. on either side the point of lapel, as at H°, but less tightly down the front. Serge the inner edge of stay to the canvas. The outer edge must have a thread of the cloth taken up with the canvas.

Place the front on the table wrong side uppermost, on a piece of cloth, if possible, and press all round the edge and the lapel with as damp cloth over. The iron must not be too hot, and the cloth must be wrung nearly dry.

Now baste the hair-cloth very thickly to the canvas, to keep it in position ; it must be slit at the shoulder and opposite the top of the darts. [See **61**.]

When this is done a strip of linen ¾ in. wide

should be basted over the edges to prevent the hair working through the cloth; it must be caught to the canvas on one side and the hair-cloth on the other rather loosely.

Now take a piece of linen 6 in. wide for button and buttonhole stay; first press it, then place it ½ in. above the break of lapel to 7 in. below waist-line. Baste to canvas loosely ½ in. in from the edge, and secure to this with several rows of basting.

We are now ready for the facing; the outer edge of this must first be shrunk to match the edge of front from T to bottom. It is safest to place the facing on the front and measure carefully from T to find how much has to be shrunk out. This must be done with a damp cloth and a rather warm iron. Place the facing on the right side of fore part, face to face, with the shoulder to the left; baste from the bottom, keeping the facing easy at T to 1 in. below this, and quite full round the lapel; machine ¼ in. from the edge, beginning at the bottom, round the lapel to H^a (any seams with a fulness on one side must always be stitched with the fulness underneath). Cut the edges even to within ⅛ in. of stitching, open and press the seam; turn the facing back, working out the points with a bodkin; baste the edge of lapel, working the seam ⅛ in. under, so that it shall not be seen on the right side; baste again along the break, pressing the cloth towards the point, and put one or two stitches more near the point; this should be done over the band to make the lapel curl under; now baste the edge below lapel, working the seam ⅛ in. in, keeping it easy at the portion marked T; baste again through the centre and the outer edge.

The left front must be made in the same way.

Putting Material Together. We next proceed to put the back and side pieces together. In all cases the waist-lines must be kept even. If this is not done there will be what is called a "twist." The seams must be basted thickly (four stitches to the inch), ¼ in. in from thread-marks. First baste the centre-backs together, next the curved side-pieces; one must be basted from top to bottom, the other from bottom to top—the back part must be uppermost when doing so.

Before basting the under-arm to fore part, a little attention must be given to the inlays. The edges must be damped and stretched on the sleeve-board with a warm iron, great care being taken to keep clear of the thread-marks, as the edges only are to be stretched until they have a wavy appearance. If this is not done the inlay will contract the outside.

Having stretched the edges, baste the under-arm to fore part and shoulders, remembering to stretch the latter towards the neck when basting to the back shoulder.

The coat is now ready to try on. If the measurements have been taken correctly, there should be very little, if any, alteration required; but, should any be necessary, it must be made at the shoulder and under-arm seams.

When the coat has been fitted, the seams (with the exception of the shoulder, which must have the basting removed and be left free) must be stitched with silk.

Remove the basting very carefully, otherwise the cloth will be damaged; press the seams, stretching 1½ in. above and below waist, to make them fit in the hollow and fall freely on the hips.

Now turn the bottom up to thread-marks and baste.

This can either be stitched to match the fronts or serged to the cloth. If the latter, it must be done with a fine needle and silk, and only a thread of the cloth taken up, as on no account must the stitches show on the right side. Serge the bottom of facing to the inlay neatly, and the facing to the canvas. Turn back the lapel in its proper position and fold the edge of front back from centre-line; this is to prevent the facing being tight. Remove the basting of fore-part, except the centre-line. Stitch the edges close to the edge and at least ¼ in. from first row. Now space the buttonholes and work them. [See lesson on Buttonholes in Boys' Tailoring.] Six should be worked 2 in. apart, the first being level with T and ¼ in. longer than diameter of button.

To obtain the positions for buttons place the right front over the left, with the centre-lines directly on each other, as from H to P. Mark through the eyes with a piece of chalk, which gives the correct position. Now turn the right front-back from centre-line to get the position for the other set of buttons; mark through the eyes as before, and place a thread-mark in each chalk-mark.

The buttons on the left front must be sewn on as already described in Boys' Tailoring—*i.e.*, with a stem. Those on the right, however, do not need a stem, as they are only for ornament. The buttons must not be sewn on until the final pressing has been given.

If pockets are required, they can now be put in, and should be of the jetted or piped kind, which are made in this manner.

The Pockets. For the position and shape of the opening, see **58**. First make a heavy chalk-line along the opening 5 in. long; take a piece of cloth not less than 2 in. wide and ½ in. longer than the opening; place this over the chalk-mark face downwards, and pat well with the hand; raise the piece of cloth, and you have the correct shape of opening. This is for the piping, and should be cut 1 in. wide below the impression; cut another piece to match, for the top; place a linen stay on wrong side of opening on the thread-marks, ¾ in. on either side; baste all round, turn the coat over, place the two pipings above and below and quite close to thread-marks [**63**]; baste to coat.

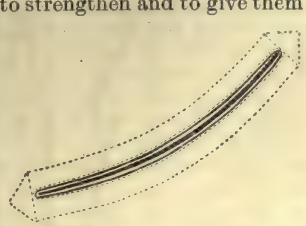
Now cut the front of pocket 6 in. square, cut the top same shape as opening, leaving 1 in. at each end, which must be curved, as in **63**. Place this on the lower part of pocket, curved edge to curved edge, baste together, and stitch ⅛ in. above and below opening.

Before turning the pocket through stitch the bottom of piping to the pocket, cut the opening between the stitching to within ¼ in. of each end, and nick the corners, as in previous lessons; turn the piping through, work the corners even, press the seams and baste the piping of lower edge back. Treat the top in the same way.

Now take the back of pocket, which must be 1 in. longer than the front, stitch a cloth facing 2½ in. wide along the top, as described for boys' pockets, place on the wrong side of opening 1 in. above, facing underneath; baste in position, turn the coat over, stitch the top of pocket from end to end as close to the piping as possible. A second row of stitching can be made, if desired, to match the fronts.

Now turn back the back of pocket, and stitch the lower edge to match the top; turn the coat over, baste the front and back of pocket together, taking in the linen stay each end and round the corner. Machine all round, beginning and terminating ½ in. on each side of opening.

Turn the coat over and stitch the corners, as shown in **64**, both to strengthen and to give them a neat appearance; remove the basting, and close the opening with three or four stitches taken through the piping.



64. POCKET OPENING

Now give it a good pressing on the wrong side, with a damp cloth over, to make the edges of opening as thin as possible.

Place a piece of dry linen over the front facing, with the lapel turned back in its proper position, and press well with a warm iron.

Should there be any shine on the right side, caused by the pressing, take a piece of linen, wrung as dry as possible, and a *warm* iron, and go over the shiny parts very carefully. On no account let the iron rest on the cloth an instant, but lift it up and down all the while. Remove the linen, take a clothes-brush with an unpolished back and pat all over the parts pressed, to prevent the steam from rising, then lightly raise the nap with the brush.

The Linings. The greatest care should be exercised when basting linings inside coat, as here we have one of the chief difficulties in ladies' tight-fitting garments. As in the case of outside cloth, so it is with the linings; the curves and ease in length and width must be fairly equalised along all seams and over all portions of the body-pieces, as, if this is not attended to, the garment will be contracted, and twist in every direction, quite ruining the fit.

There must be an ½ in. pleat in the centre-back and shoulders, and two or three small ones round the front of the armholes. Each piece must be quite easy in width and length, particularly in the hollow of waist and across the bust, and should be nicked 1 in. above and below waist.

The seams of the linings should in all cases follow exactly the lines of outside seam. In basting allow each piece dealt with to lie smoothly in front of you, and, in addition to basting in position, baste them thickly along the seams previous to felling in position.

The linings can be made up separately if desired, in which case they must be basted together on the same lines as the coat itself, keeping the waist-lines together. The backs, curved side pieces and under-arm pieces should be basted and machined, then basted to the coat, waist-line to waist-line. Place front lining on the facing; baste on "easy," with the edge of coat towards the worker, keeping very full across the top of darts; baste and secure with back and fore stitch [see STITCHES, BOYS' TAILORING]; remove and baste carefully.

It is advisable to cut the threads here and there; turn the lining over, and give a thumb press, bringing the lining a little over to hide the stitches. Baste the darts to the darts of coat, and waist-line to waist-line, fulling the lining a little towards the facing. Turn in the edge of fore part, place over the under-arm seam, waist-line on waist-line; baste the bottom, and fell in place.

After inserting the linings, baste and machine the shoulders; remove the basting, open and press well, stretching towards the neck; baste the canvas to the shoulder seam, well stretching it; baste the lining over the canvas.

The Collar. Procure the proper linen canvas, cut on the bias—not quite on the cross—as directed for Boy's Coat, then place the pattern on the canvas, chalk-mark all round and along the creased row. Two pieces will be required, also two pieces of cloth on the bias, for the inside collar. Cut the pattern, allowing ¼ in. extra on the cloth all round, and mark the crease with chalk, both in canvas and cloth. The material for the inside collar—which is the part we have to turn our attention to first—may be either of the same as that of coat—thin Melton—or Italian cloth of the same colour.

Overlap the centre seam of canvas and baste with small stitches, to hold together; run a thread through the chalk-mark of crease, place the canvas on the table or sleeve-board, with the stand towards the worker.

Now press the edge of stand back with a hot iron until it lies flat on the fall, slightly stretching the outside and shrinking in the crease (the crease must not be stretched, or the collar will stand out at the back of the neck when on).

Inside Collar. Place the canvas on the cloth, with the crease-rows together; run a thread through the crease of both canvas and cloth, to hold together.

Machine the stand with several rows of the stitching; the closer the rows are together the better, the object being to give firmness to that portion of the collar.

The object of the padding [see BOYS' TAILORING] is to make the collar turn inwards, so the canvas is put on somewhat fuller than the inside collar to obtain this result.

It is absolutely necessary that the crease-rows should be kept together throughout the making of the collar, and the padding must be done as thickly as possible, starting at the crease and leaving the cloth clear ¼ in. all round. When this is done, a drawing-thread should be run through the crease-row and drawn tight—though not too tight—to prevent it stretching.

Continued

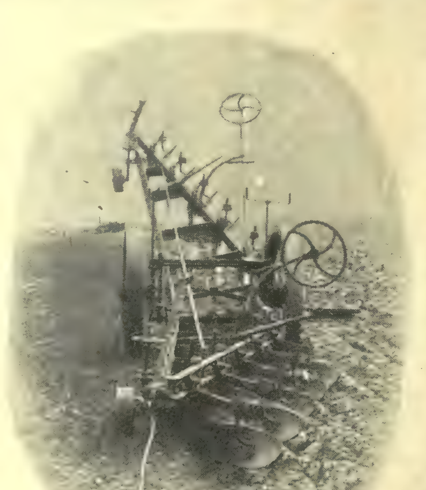
Group 1
AGRICULTURE
13
Continued from page 1669

MACHINERY OF THE FARM

The Necessity for Up-to-date Implements. The Self-binder and Reaper. The Plough. The Smaller Tools

By Professor JAMES LONG

How to Purchase Tools. In the management of a farm perfect equipment is half the battle. Nevertheless, it is probable that on the majority of British farms the implements and machines employed are of old type, involving slow and inefficient work. The great feature of to-day is to save manual labour, and thus to minimise its cost. Farmers with capital are prone to pride themselves on a smart outfit, new and brightly-painted carts and waggons, costly harness, abundantly furnished in brass, with tools and tackle all of the best. Money is well spent if it is spent judiciously in buying not only the best, but no more than is required. A man with experience, however, is able to obtain many useful implements and machines as he needs them by attending farm sales, but the amateur or the non-expert, before attempting this method of purchase, should ascertain the market price of his various requirements, and, above all, which are the most substantial and useful. From time to time new implements are introduced by manufacturers, many of which are of great merit. For this reason the best agricultural shows should be attended at least once a year—the Royal, and, let us suggest, the exhibition of the county in which the farmer resides. Before making a purchase, however, it is well, where the same class of implement or tool is made by various firms, to compare them as far as possible on the show-ground in order to learn their relative price, strength, and capacity for work. Farm tackle bears a good discount, and the buyer should not forget this point, whether in dealing direct with the maker or his agent. As far as possible, implements should be manufactured of wrought iron or steel and wood—where wood is employed—of the toughest kind; and it is here that, as a rule, British goods are so much superior to those made both in America and on the Continent. Again, wherever possible, implements and machines should be selected in which the wearing parts can be most easily replaced, and here there is great difference in the productions of the various makers.



A STEAM PLOUGH

Carts and Waggons. Carts and waggons should be made of the best and toughest timbers especially where the greatest strain occurs, and provided with strong axles, substantial wheels, strong arms and raves, good bottoms and extra strong angles [p. 1629]. Care should be taken in making a selection that the wheels and tyres are of such a width as the nature of the soil demands. Good carts are sometimes—more often in the past than the present—made on the farm where a skilled wheelwright is obtainable. A cart should tip easily, and where intended for use in hay-time and harvest, it should be provided with ladders, back and front, which, like the arms, should be liable to as little strain as possible. Carts and waggons should be kept well painted, the best white-lead and oil being used, and always under cover when not in use. As a rule, it is probable that more damage is done to both by exposure to rain than by work. A liquid-manure cart is essential upon a farm of average size. There are many makes, some extremely clumsy, others light and strong, with well-arranged mechanism. The metal of the tank should be stout, choking or blocking should be impossible, while delivery should be wide and effective.

The Self-binding Reaper. The self-binding reaper is one of the greatest labour savers in modern agriculture. Few farmers have sufficient experience to differentiate between the various makes and to select the best with a degree of certainty. This machine should be little complicated and light in construction—a most important feature — but it should be strong. Bearing in mind the difficulty in the case of a buyer with little or no experience in making such a purchase, we would suggest that instead of depending upon his own judgment he should ascertain from other farmers the results of their experience with the machines they possess, and select that which has done the best work and required the least repair. It is well, too, to see two or three of the best binders at work on similar land to that occupied and on similar crops to those grown by the intending buyer. When a

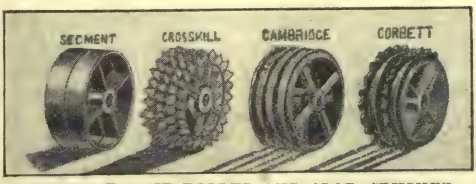
machine is decided upon, the buyer should learn from the seller to appreciate the value of every working part, and how to take the machine to pieces for the removal of breakages, and for replacing wearing parts. The farmer should, indeed, master the mechanism of the binder, and especially learn how far he can himself repair it, and when it becomes necessary to call in the aid of a skilled mechanic. All wearing and other parts likely to be required during harvest should be kept on hand, and especially the knife sections, fingers, rivets, nuts, screws and sheets.

The ordinary reaper cuts corn in a similar manner to the self-binder, revolving sails sweeping it on the ground in untied sheaves as it falls on the platform, leaving it to be tied by hand. This machine, although heavy to work, is less complicated, and is useful where tying is impossible. A combined grass mower and reaper is made by some firms, removable parts being attached for cutting corn; a second man rides with the driver, and sweeps off the corn by hand in sheaf-size lots as it is cut. In each case wearing parts should be in stock, the machine regularly examined, cleaned, oiled, painted where necessary, and always in workable condition.

Pulper — Finger-piece Cutter — Grater — Slicer

DISCS SHOWING ARRANGEMENT OF KNIVES FOR CUTTING UP ROOTS

Potato Raisers. There are several implements or machines in the market which are intended to raise the potato crop with expedition and completeness. The simplest is the ridging plough, to which a specially square-pointed head and breasts are attached. When at work the point of the implement passes beneath the tubers, which, with the soil, are thrown right and left, ready for picking up. A more elaborate machine is made with a broad, horizontal blade, which passes beneath and lifts the potatoes, with the soil and haulm attached, and which are separated by revolving tines at the back of the machine. Better and quicker work is performed than with the plough, which necessarily leaves some tubers in the soil, these being recovered only, but not always entirely, after harrowing. A still more elaborate and costly potato raiser, made on a similar principle, lifts the tubers clear of the soil, raises, sorts, and bags them at one operation. It is questionable, however, whether it is really economical in practice to bag potatoes which have not been allowed to remain exposed to the sun and air to dry before picking and bagging.



TYPES OF LAND ROLLER AND CLOD CRUSHER

Drills. Drills are made in great variety, but chiefly on two principles. In the cup drill the seed receptacle is carried between two wheels, a second pair of wheels in front being chiefly employed for steering. Passing through the seed receptacle is a rod upon which are discs fitted with small cups. When at work and in gear the rod revolves, the seed is picked up by the cups from beneath, and dropped into vertical cylinders, and thence into somewhat heavy metal coulters, which are drawn through the soil, in which they make narrow furrows, into which the seed is deposited as they pass along. Cups of various sizes are employed in accordance with the variety of seed used, while the quantity sown is regulated by the aid of cog-wheels, which are changeable, and which increase or decrease the revolutions of the cups as may be necessary. The cup drill does not sow exceptionally large or small seeds, such as beans or grasses, the system of regulating the quantity per acre is imperfect, and there is no possibility of measuring the area sown. The drill, too, is cumbersome and heavy in draught, and therefore slow in work, while it requires more horses and men than should be essential. On the other hand, the force-feed drill is of lighter construction, drawn by two horses instead of three, and worked by a man and a boy. A larger variety of seed can be sown with greater accuracy and speed, and the area sown can be measured.

The Mangel-drill. Small drills, drawn by one horse, are employed for mangels, and here specially-formed rollers are attached to fit the ridges beneath the surface on which the seed is deposited. Large numbers of farmers, however, employ the cup drill already referred to, but in this case the ordinary receptacle is removed and replaced by one of larger size, which takes both seed and manure, which are simultaneously drilled. Here, again, however, the machine is still more cumbersome and inadequate. The sowing of grass seeds by the aid of a separate attachment is practically impossible with the cup drill, but the practice is followed where the force feed drill is in use. The writer has long advocated the manufacture of a combined machine which, having deposited the seed—both corn and grass—when required, harrows it in at one operation; but, so far, no such labour-saving machine has been produced which comes up to the requirements of the case.

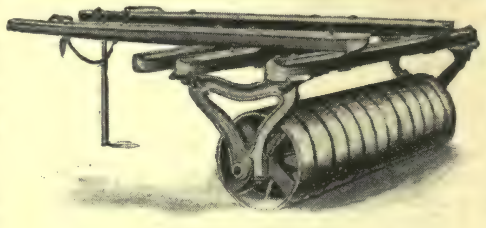
The seed-barrow is an implement composed of a very long, V-shaped box with a lid, which is divided by partitions into compartments [p. 872]. At fixed distances there are discs with holes of various sizes, either of which are opened in practice in accordance with the quantity and variety of seed used. Passing through the length of the box is a rod upon

which circular brushes are fixed. When in work these brushes revolve and push the seed through the holes opened for the purpose. The seeds sown by the seed-barrow are grasses and clovers, the implement being wheeled across the field by hand. There is, however, no system of regulation beyond that referred to, which is primitive and unworthy of advanced agriculture.

The Threshing Machine. The threshing machine is large and heavy, but cleverly constructed; it is driven by a steam-engine, to which a belt is attached. The machine is placed beside the corn rick, the sheaves or loose corn are tossed on to the platform, passed into the machine by the feeder, the grain is removed from the ears, screened, and in due course shot into a sack suitably placed to receive it. Simultaneously the straw, cavings, chaff, and rubbish—chiefly dust and weed seed—are deposited outside, while the tail, or inferior corn, passes into a second sack. It is seldom that a threshing machine is found upon a farm, the practice being to hire it when required, on conditions which vary more or less in accordance with the practice in the district.

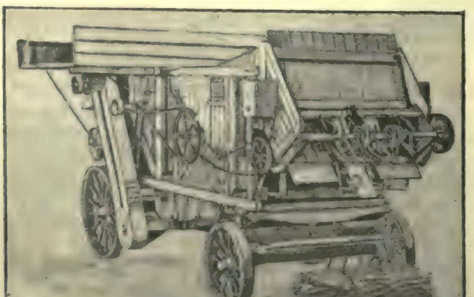
The Straw Trusser. The straw trusser is now made for attachment to the thresher, so that, when required, the straw may be tied in trusses for sale as fast as it comes from the machine. It is costly, but is frequently obtainable on hire from those persons who let out threshing machines.

Presses. Hay and straw presses are now comparatively numerous, and are made for both steam and hand power, the smaller hand-machine enabling a capable workman to tie a large quantity of hay —for which they are chiefly used—in a day, string being employed instead of hay or straw bands, which occupy much time in making, while the pressed hay occupies much less space on the waggon and in the railway truck, and consequently costs less for conveyance to the buyer. It is important that the hay press should be strong, and that a weighing apparatus should be attached.

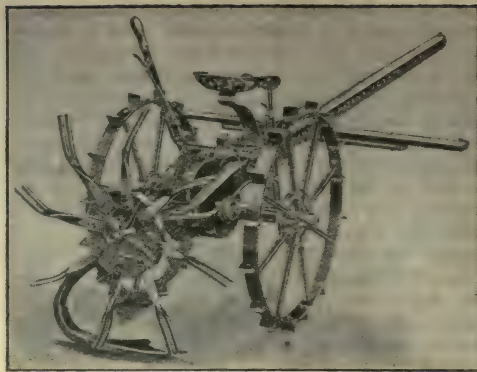


IRON LAND ROLLER IN SECTIONS

The Weighing Machine. The weighing machine is chiefly employed for granary work, or for checking the weight of cake manure and seed.



A THRESHING MACHINE



A POTATO RAISER

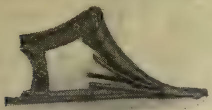
On some farms a weighbridge for weighing stock forms part of the equipment.

The Winnower. Before delivery the already threshed corn is passed through the winnower, that it may be further cleaned and dressed, and that in consequence the sample may be finer, and realise a higher price. The blast of this machine should be sufficiently effective to remove what is not rejected by the screens and riddles, especially in the case of barley. Hand samples of dressed and undressed barley, wheat, or oats, placed side by side, will show the importance of the process, two or three light grains being sufficient, in the buyer's eyes, to warrant a reduction in price.

The Mowing Machine. A necessary implement on all farms, the mowing machine is used for cutting grass, clover, lucerne, sainfoin, and mixtures [p. 1629]. The knife works on the principle adopted in the reaper, the crop being laid in even swathes. It is important that the mower should be at once light and strong, and among the many makes in the market it is now somewhat easy to obtain what is required.

The Horse-rake and Hay-drag. Made in two forms, it is desirable that the horse-rake should be as wide as possible, in order that a considerable sweep may be taken at one operation [p. 1630]. Owing, however, to the limit of the width of gateways, it is necessary that the wider rakes should be expansive and contractive at will, and thus it is that we have the telescope horse-rake. The machine should be light, suitable to one horse, and so simply constructed that the hay, when raked, may be easily released by the driver. The tines should be flexible, and all parts easily replaced when necessary. The horse-rake, which is used for both hay and corn, is now supplemented by the hay-drag, which is drawn by a team of horses, one at each end of the implement. The strength employed enables the driver to collect a very large quantity of hay, and to deliver it at the foot of the rick if necesssary.

The Haymaker and Swathe-turner. The haymaker is an implement upon which are a number of revolving tines or spring teeth, which pick up the partially-made hay, lift and toss it into the air The machine practically supersedes the old-fashioned and still common method adopted by the workmen with the hayfork [pp. 1628, 1631].



Attachment for lifting potatoes

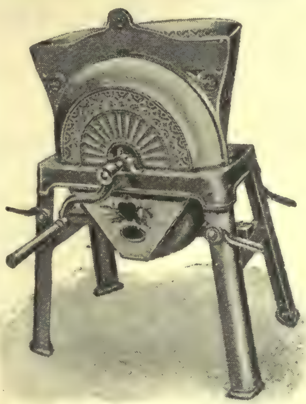
Double breast for ridging

PLOUGHSHARES

The swathe-turner is a comparative new machine, which, the upper side of the newly-cut grass being dry as it lies in swathe, turns it over cleanly and rapidly, that the under side may be dried also. This machine is one of the most important and valuable on the grass farm.

The Hay-loader. A machine of American invention, the hay-loader is intended to pick up hay as it lies in windrows and elevate it to the waggon, thus dispensing with a couple of men [p. 1632]. Its work is rapid and useful, but the land still needs raking in the ordinary way.

The Elevator. The elevator is a large implement, worked by the aid of a horse, which conveys upon metal-tined carriers travelling on endless chains the hay or straw from the ground or the cart to the top of the rick which is being built. It is a labour-saving implement of great value, although costly in the first instance [p. 1629].

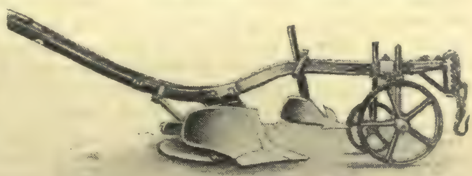


ROOT PULPER

The Plough. The one implement without which arable land culture is impossible is the plough [p. 1229]. The number of makers, and the variety made by each maker, is so large that the buyer of a plough may be excused if he becomes confused and finds selection difficult. Having, however, decided upon the type and the maker, his wisest plan is to ask that a skilled workman may be sent to the farm with a suitable assortment, and that each may be tried on the land, for much depends upon the selection of the best and most suitable implement. Something may be learned by examining the work performed on neighbouring farms if the soil is similar, and noticing the principle adopted. Again, when several ploughs are being tested, it is well to invite neighbouring farmers of experience to witness and criticise the work, and to compare it with their own. The object of ploughing is chiefly to prepare a seed-bed. To this end the soil may be ploughed sufficiently deep and laid up so that it will pulverise as perfectly as possible. It is also important that the work should be done with as little draught or waste of power, and as quickly as possible. The plough selected should be one in which the wearing parts of the breast, as well as the points and fins, should be replaceable. It may be that a double-furrowed plough will prove the most economical, and that three or four horses, driven by one man, will do as much work as two pairs of horses and two ploughs driven by two men, or that a riding plough will better satisfy the ploughman, and encourage him to do more or better work. It is time that the cumbersome ploughs employed in Kent and other English counties were replaced by the modern iron and steel ploughs, which do more, if not better, work, with less draught. Additions for skimming, sub-soiling, and broad-sharing should, if possible, be obtained for attachment to one and the same implement.

Harrows. Harrows are of various forms, sizes and weights [p. 1231]. Seed-harrows are light in structure, sharpened tines being fixed with nuts to iron frames. A set usually consists of three or four distinct harrows linked to a wooden bar, to which the draught-chains of the horses are attached. Heavier harrows for working down the soil and preparing a seed-bed are made both with iron and wooden frames, the latter sometimes being very clumsy. Drag-harrows are provided with bent tines, which enable them to pierce the ground to greater depth, and thus break up clods which are almost or entirely buried. Chain-harrows [p. 1379], made in various forms, consist of a number of iron links, which are usually provided with points on one side. These are intended for work on grass-land in spring, and, as occasion requires, on arable land, especially where it is necessary to collect weeds and other materials brought to the surface by sharp-pointed harrows.

Cultivators, Grubbers, and Scufflers. Implements drawn upon wheels, and provided with curved tines intended for entering the soil, reducing the size of the clods, preparing tilth, and removing weeds, cultivators, grubbers, and scufflers, are made in various forms and sizes. In some cases modern cultivators are combined tools—broadshares for paring the surface, hoes, and duck-foot shaped points being provided for



HORNSBY'S DIGGING PLOUGH

replacing the tines as occasion requires. The tines, like the other wearing parts named, are raised from the ground by the aid of a lever when the implement is out of work. More recently flexible or spring-tined cultivators have been introduced.

Rollers. The roller is made in several forms, the modern implement being of iron [p. 1843]. The weight, width, and diameter of the roller depends upon the work it is intended to perform. It is made to resemble a whole cylinder, or a cylinder in sections, or it may consist entirely of rings, each of which fits loosely on an axle. The clod crusher, another form of roller, consists of rings, which are serrated. The roller is used on grass-land intended for hay, on arable land after sowing, and on land in process of cultivation at various stages, when it becomes necessary to reduce the coarse soil into fine tilth.

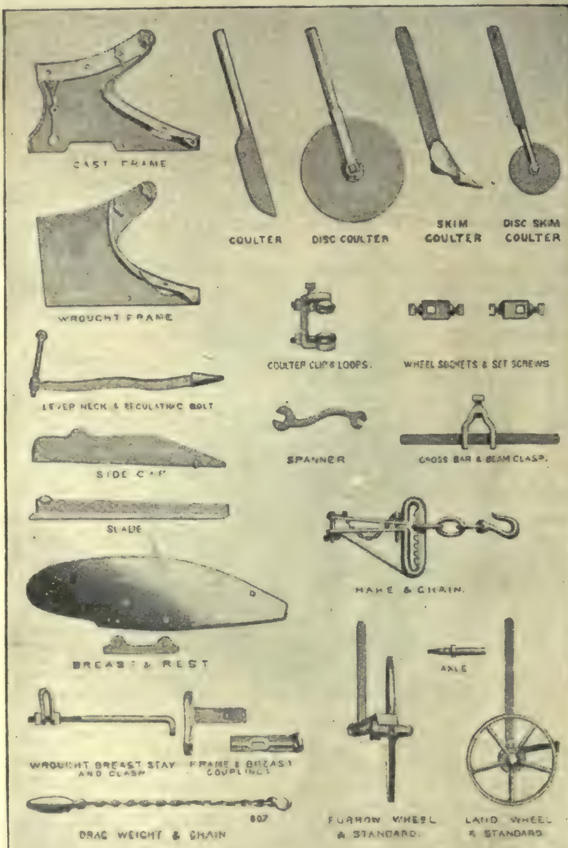
The Grinding, or Grist-mill. Used on most farms where steam is employed, the object of the grinding, or grist-mill, is to provide the meal intended for feeding stock in general and for crushing, bruising, or kibbling oats, maize, barley or wheat. In most instances the wearing parts of grist-mills, which are easily replaced when worn, are made of steel, but where the workman in charge is able to dress his own the stone mill is found the most satisfactory.

The Pulper, or Slicer. The pulper, or slicer, is intended for cutting up mangels and swedes into pulp, slices, or finger-pieces in the preparation of a stock ration. The knives [p. 1842] should be reversible or easily replaced, and the machine should be one which cannot clog. The knife discs are usually vertical, but a machine now exists in which they are horizontal.

The Chaff-cutter and Cake-breaker. The chaff-cutter cuts hay and straw into short lengths, either by hand, horse, or steam power. The material is placed in a wooden trough, drawn forward by the action of specially made rollers and under the revolving knives, which, fixed on a fly-wheel, pass rapidly over the face of the pressed fodder. It is now essential, to comply with the law, that a chaff-cutter should be so constructed that it is practically impossible for the workman feeding it to meet with harm.

The cake-breaker is a machine intended to crush into small pieces the hard linseed, cotton-seed, and other cakes which are used for stock. As each cake is passed into the machine it is seized by the spiked rollers provided for the purpose of breaking it down. In the best machines there are two pairs of rollers.

On every farm there are many minor implements and tools which are essential, one or more being in demand on almost every working day. These include hand and drag rakes necessary in the hay and corn field; a hay-knife for cutting hay or straw from the stack; two or three scythes, with stone rubbers; a grindstone, which should be of the best make obtainable; a weighing machine, with a guard intended to hold up a sack of corn; milking-pails and stools; cattle-chains; stable equipment, including corn-bin, sieves, brushes, curry and mane combs; lanterns, forks, shovels, brooms, spades, hoes, and rakes for fine work; beetle and wedges for splitting timber; an axe; a cart-jack; various spanners; tools suitable for hedging, cleaning ditches, draining, the mending of gates and fences, and painting of waggons, carts, and the various implements of the farm.



THE PARTS OF A PLOUGH

Continued

THE POOR LAW SERVICE

The Administration of the Poor Laws. Outdoor and Indcor Relief. The Service as a Career

continued from page 1680

By ERNEST A. CARR

Administering the Poor Law. With a single exception, our survey of the municipal service is now complete. Hitherto we have been concerned mainly with the councils of the various counties, boroughs, and districts, each of which bodies, as we saw, is elected for a variety of purposes connected with local government. The boards of guardians, whose work we are now to consider, have no direct relation with these authorities, and are entrusted with no such general powers. They are elective bodies of a quite special class, charged with only a single function, but that a very important one—namely, the administration of Poor Law relief to the destitute poor.

The guardians of the poor, indeed, are the unpaid official almoners of the nation's charitable doles to those of its population whom adverse conditions prevent from supporting themselves. Under the strict direction of the Local Government Board, the funds raised for this purpose by means of the Poor Rate are administered by the guardians through the agency of a large staff of officers of various grades.

Indoor and Out Relief. The help thus rendered to the poor is of two classes. Outdoor relief, in the form of weekly grants of money, food, firing, and free medical aid, is sometimes granted in cases of temporary want, and is also given under certain conditions to enable the widowed, aged, and infirm to keep the grim wolf Hunger from their doors. For the rest of the sad army of poverty there is the system of indoor relief, comprising various institutions in which the destitute are housed and cared for. In addition to the workhouses, they include cottage homes and schools for the children, infirmaries for the sick, asylums for the insane, and casual wards as purely temporary shelters. This main distinction between indoor and outdoor relief runs through all Poor Law matters ; and, as we shall see, it affords a convenient means of classifying the various members of the staff employed by the guardians.

The Problem of Relief. The developments of the past year or two have awakened unusual interest in the problems of pauperism, and every thoughtful reader must have reflected on the grave responsibilities with which the guardians of the poor are entrusted, and the heavy cost of the pauper to the State. The growth of the Poor Rate, the classification of workhouse inmates, Poor Law labour colonies, the treatment of tramps, the wisdom or unwisdom of extensive out-relief—such aspects of this great national question are constantly under debate in the public Press. To discuss them here would be idle. But it will help us to grasp the great importance of the Poor Law service if we consider for a moment the latest official returns of pauperism.

These show 273,386 indoor and 575,613 outdoor cases receiving relief in England and Wales, which gives a total of 848,999 persons (including almost exactly a quarter of a million children) maintained at the public expense. During the last recorded half-year, their cost amounted to £7,096,847, made up as follows : Indoor maintenance, £1,769,607 ; outdoor relief, £1,576,865 ; support of insane paupers, £1,178,572 ; salaries of officials, etc., £1,203,920 ; and other charges, £1,367,883.

The Service as a Career. The item for officers' salaries reminds us that it is time to turn from more general considerations to discuss the aspect of the Poor Law service in which we are specially interested—namely, the prospects it affords as a career.

Excepting always the medical section, it must be admitted that the attractions of this branch of municipal work, for men of real ability and ambition, are somewhat scanty. The service, as a whole, suffers from lack of organisation and system. There are no educational tests prescribed for candidates on entrance, and no suitable qualifications by means of which an energetic subordinate officer may demonstrate his fitness for advancement. The complaint is general throughout the service that many efficient officers remain for weary years, not only without promotion, but without even the smallest advance of salary to reward ability or encourage endeavour. Further, while posts of distinctly inferior grade are properly remunerated, there are few appointments of intermediate worth, and still fewer really valuable prizes. These defects combine with the popular outcry against the burden of the Poor Rate to keep stipends small ; and the general level of salaries for clerical and executive work under the guardians is certainly lower than that prevailing under the local councils.

An Expert's Views. In connection with this matter, it should be mentioned that a powerful voluntary organisation exists in the service, under the title of the National Poor Law Officers' Association, for the dual purpose of increasing the efficiency of officials and of improving their status. A former President, Dr. James Milward, of Cardiff, has expressed himself so justly and wisely on the prospects of the service that his remarks merit quotation.

" It will, I think, readily be admitted," said Dr. Milward, " by most people who have had much practical experience of the Poor Law, that its great fault is that it stands almost or quite alone

among the branches of the public service in not providing a career for its members. In our Civil Service generally the prospect of promotion is active in stimulating the official to do his duty—and a little more. Unfortunately, here there is no such motive. No matter how able, zealous, or efficient an officer may be, he never passes from one grade to a higher. There are no prizes in his profession."

Uninviting Prospects. That the state of things thus sketched calls for an effective remodelling of the Poor Law system is hardly to be denied. The aims of the Association in the direction of reform are thus summarised by the authority already quoted: "We have still before us the two great problems of the training and promotion of officers, with all that those problems involve. First comes the question of the examination of the candidates for the various branches of the service. Instead of adult applicants for posts relying on their own persuasive powers or the influence of friends, they should qualify themselves, as in other branches of the public service, by examination when young; and entering the service at the bottom, should learn their business in subordinate offices, and rise according to their abilities, with salaries graduated according to their posts and the length of their service." And in connection with this project, Mr. Watson Rogers, the present President of the Association, writes to endorse Dr. Milward's views, adding: "I may say that one of the planks in our platform to-day is the formation of an Examination Board for the issuing of certificates of proficiency for existing officers who desire promotion, and for others who desire to enter the service."

Humanising the Poor Law. There are indications that some such reorganisation as is here depicted may be expected in the near future, though it is as yet too early to attempt a precise forecast. The powerful Royal Commission on the Poor Law, which is now sitting, may effect some improvement. Its terms of reference include the following: "To consider and report whether any, and if so, what modifications of the Poor Laws, or *changes in their administration*, are advisable." The expression italicised is wide enough to include proposals for a complete reconstitution of the official staff and the advancement of its capable members.

Prospective candidates must not overlook the fact that the work of an officer of the guardians is almost always performed under conditions which to a sensitive nature are depressing or painful. He is brought into daily contact with the direst poverty and all its attendant miseries of dirt, disease, and vice. To a humane public servant, however, this very circumstance gives his work among the obscure poor its greatest dignity and worth. It offers countless occasions for helping the helpless and befriending those who sorely need a friend. In the case of applicants for relief or maintenance, the relieving officer is charged with the duty of fully investigating their circumstances and character before their request is submitted; and, in deciding the nature and extent of the aid to be offered, the board is necessarily guided in the main by that official's report. Similarly, the fortunes of the appeals of workhouse inmates for special leave in search of work, indulgences in the matter of diet, and other privileges, are largely determined by the views of the guardians' clerk and the master or matron of the house. These instances will show what responsibility and power the Poor Law officer possesses, and what scope his work affords for patience, conscientiousness, and humanity. In this connection it is noteworthy that a leading municipal authority, whose opinion the present writer sought as to the most useful branch of Local Government work, replied as follows: "For a career of sheer usefulness and service, as distinguished from high monetary reward, I regard the administration of the Poor Law as foremost, and would specially mention the valuable work of the nurses in our infirmaries and hospitals for the pauper classes."

How We Have Improved. How vastly official methods of treating pauperism have progressed since the days when the "sturdy beggar" was whipped, branded, and enslaved, readers will scarcely need to be reminded. The records of Exeter Workhouse show that two centuries ago the task of "performing cures on wounds and sores" on the hapless inmates was entrusted to the tender mercies of—the beadle! The strides made during even the last fifty years or so toward a humaner method can best be realised, perhaps, by comparing a modern workhouse with that described in "Oliver Twist." Yet much still remains for individual effort to accomplish in the humanising of the Poor Law.

A single instance, selected almost haphazard from among many such, will serve to illustrate the possibilities of kindly service awaiting the humane official. The introduction into Hull Workhouse of the "Brabazon" system of skilled work, which has added a new pleasure and interest in life to many of the unhappy inmates, was due in the first instance to the consideration of the master and matron. To be able to soften in ways like this the operation of a Poor Law system which in itself is apt to be hard and grim, is a prospect which might have tempted St. Francis of Assissi to become a guardians' officer.

Service Pensions. Under the Superannuation Act of 1896, servants of the guardians, in return for a deduction which in the case of new appointments is two per cent. of their pay, are entitled to resign on two-thirds salary after forty years' service, or on a smaller proportion if invalided earlier. Female nurses and attendants may join the scheme or not, as they please; but with all other officers the system is compulsory.

In our next paper we shall consider more in detail the various grades of Poor Law posts, classifying them, according to the main line of cleavage running through the service, into indoor and outdoor—or resident and non-resident appointments.

Continued

PROCESSES IN CEMENT MANUFACTURE

Details of the Dry and Wet Processes. The Machinery and Plant Used. Cement Compositions, Analysis and Tests

By CLAYTON BEADLE and HENRY P. STEVENS

Dry Process. In describing this process we think it best to take the case of a typical instalment just as if we were going over cement works using the process, and describing the plant [20, 21 and 22] we should find there.

In the typical process we have chosen the plant illustrated treats limestone of average hardness, and clay shale. The output is 60,000 tons of Portland cement per annum, so that assuming that the kilns work 300 days per annum, we get an average output of 50 tons for each kiln per day.

The raw materials are brought to the works in tip waggons on rails (1), and are weighed outside to control the proportion of the ingredients. The raw materials are tipped into the three crushers (2) and (2b), the first of which is used for shale, and the two others for limestone. These crushers are arranged between the four dryers (4), and connected with them by means of the elevators (3), so that each of the crushers can be connected with either of the two drying drums which lie one on each side of it. This precaution is taken in case one of the dryers should be put out of action for repairs.

The materials are kept separate as they pass through the dryers, and are thence distributed into the three elevators (5), each of which again can be connected with either of the two dryers. The dried raw materials are thus elevated and thrown into hoppers (6), whence they are loaded into tip waggons running on the two lines of rails across to the raw mill house, and shown in section [22.] Workmen push the waggons along the line, and at the same time look after the proper distribution of the raw materials.

Preliminary Coarse Crushing. The raw mill consists of three kominors or modified ball mills, each of which holds 2½ tons of steel balls. These kominors are marked 8, and the hoppers into which the raw but dried materials are fed are marked 7, on the drawing.

Two of these placed together are for limestone, and the third grinds shale. Each material is ground separately.

After being roughly ground in the kominors the raw materials are brought by the conveyers (9) and the elevators (10 and 11) to the mixing bins or silos (2 and 12b), the first of these taking the shale only, and the two others the limestone. At the bottom of these, extracting worms (13) are arranged, which draw out a considerably larger quantity than that required to keep pace with the supply to the kiln. This excess of material is returned to the elevators (10 and 11) and mixed with the fresh stuff coming from the mills, thus helping to keep the supply of uniform composition.

Weighing and Mixing. The elevators convey the coarsely-ground rock to the automatic weighing machines. There are two separate machines, each of which is regulated so as to weigh the exact proportion of the raw material, one for the shale, and the other for the limestone. They are coupled together, so that they may automatically discharge when both are filled with the right weight of material. The surplus brought up by the elevators (10 and 11) and not required by the weighing machines is returned to the bins, and in this way a large quantity is constantly circulating through them, so that as the material is drawn off for use it represents a very fair average of the whole.

The weighed and mixed raw materials from the automatic weighing machines are discharged into the worm (16) and thence distributed to the two tube mills (18) through their feed hoppers (17). These are full-sized machines, each taking about ten tons of flint pebbles. Here the mixture of raw materials is not only finely ground but very intimately mixed.

Mixing Machinery. After leaving the tube mills the finished fine raw meal is taken by the elevator (19) and the conveyer (20) to the three mixing bins (22). A distributing worm, not shown in the drawing, runs above them. The three bins are provided with six extracting worms (23) which discharge into the collecting worm (24) on the ground level. This, again, discharges into the raw meal elevator (25), from which the raw material is distributed by means of a distributing worm (26) to the feeds (27) of the four rotary kilns.

The extracting worms, collecting worms, and elevators, however, are constantly circulating a considerable quantity of raw meal over and above that required for the immediate use of the kilns, and this surplus is returned to the bins through another distributing worm (28). This, again, is a necessary precaution, in order to ensure thorough mixing of the raw meal, and to obviate any variations which may occur from time to time in the composition of the raw materials.

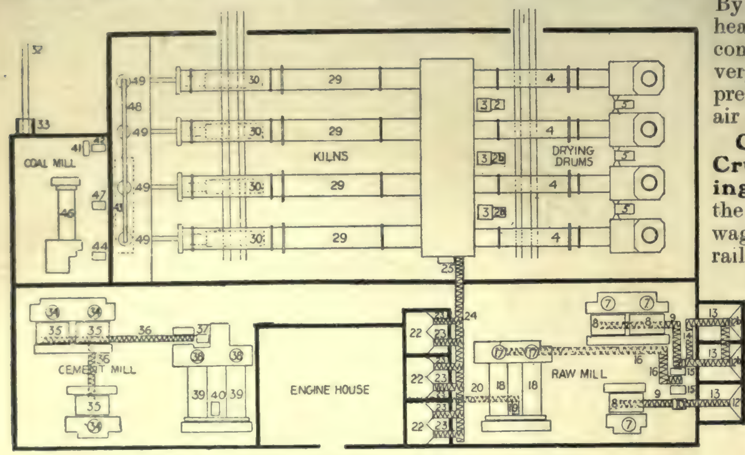
The Kilns. The four rotary kilns (29) are 30 metres, or about 100 ft. long, and 2·1 metres, or about 7 ft. in diameter. The hot clinker, which falls out of the kiln at its lower end, passes through the double clinker cooler (30), consisting of two cylinders, one inside the other. The clinker, moving along, meets a strong current of air drawn through the cooler. This air gets heated gradually to a high temperature as it is

drawn along through the brick-built room in which the drying drum for coal (43) is situated. It returns to the kiln through the fan (52).

The cool clinker falls into tip waggons (31), and is taken to the cement mill, which will be described later on.

The rotary kiln is fired by means of coal dust; this replaces coal or coke as the source of heat for burning the raw materials to clinker.

Coal Drying Plant. Special drying and grinding plant is provided for reducing the coal



20. PLAN OF A DRY-PROCESS CEMENT MILL

to dust. It is found that, as in the case of raw meal, the coal must be thoroughly dried before it can be effectively powdered.

The coal dryer, which has already been mentioned, is built in a brick-built chamber, so that both ends jut out through the walls. The coal is fed in at one end of this dryer and leaves at the other, and at the same time a small amount of air is drawn from the hot air chamber through the dryer by means of a special little fan. The coal, as it enters the works, is fed in through an aperture in the floor (11), covered with a coarse grating to prevent big lumps from getting into the elevator inadvertently.

Coal Grinding. By this elevator (42) it is taken up to the place where it is fed into the drying drum. The dried coal falls into the elevator (44), by which it is fed into a small kominor (45). Here it undergoes a preliminary, or coarse grinding, after which it is discharged into the "feed" of the tube mill (46), where the fine grinding is effected. By the "feed" of the tube mill we understand the opening where the material is introduced or "fed" in.

The coal dust is carried up by means of the elevator (47) and distributed through the worm (48) to the four coal dust hoppers (49), one for each of the four rotary kilns. Each of these coal dust hoppers is provided with a small extracting worm, the speed of which can be easily regulated by the burner or workman who controls the kiln. This worm discharges the coal dust into a nozzle (50) through which a strong current of air is driven from small blast fans (51). This is a contrivance for sucking or forcing a current of air through a machine. We may see the principle employed in ventilating restaurants and public buildings, and we have also met with it in the process of drying bricks [see BRICKMAKING].

The blast pipe enters into the large pipe for hot air driven in from the fan (52) and discharges the coal dust in a strong blast of hot air, which actually surrounds it and forces it right into the centre of the lower end of the kiln. The two pipes are seen clearly in illustration [page 1732]. By this means the waste heat is fully utilised, and the combustion of the fuel is very complete, owing to the presence of the surplus hot air surrounding it.

Clinker Cooling, Crushing, and Grinding. The clinker falls from the coolers direct into tip waggons on the systems of rails (31) and is taken away to a clinker store arranged in the yard. Later on, it can be taken on tip waggons running on the line of rails (32), or direct from the system of rails (31) to the line of rails (32).

In both cases, tip waggons are lifted by the waggon "hoist" (33), a sort of lift, to the continuation of the line (32) on a floor above the cement mill. Here the clinker is distributed to three kominors, marked 35 in the drawing, through the feeds and feed hoppers (34). After undergoing a preliminary grinding, the coarse cement is collected by conveyers (36) and by the elevators (37), and fed into the feed hoppers (38) of the two tube mills marked on the drawing 39, in which the finishing and fine grinding takes place. An elevator (40) delivers the cement on to a "belt conveyer," not shown in the drawing, which carries the cement across to the warehouse. A belt conveyer is simply a long band or belt passing over pulleys, which keep it constantly moving. The belt is horizontal, or nearly so, between the two pulleys, and the material falling on it is carried along and tipped off at the further end. It is a contrivance used for conveying material from one part of the works to another, and can be used for a great variety of materials; we shall meet with it in grain stores, flour mills, etc.

Motor Power. For driving the machinery, two triple expansion engines of 600 h.p. each are provided. One of these drives the raw mill, and the other the cement mill; but, besides this, it is arranged that either of the two engines can drive the kiln plant, with the accessory crushing and drying plant for the raw materials, and drying and grinding plant for the coal. Then, if one engine breaks down, the other is available. This precaution is necessary, as it is of the greatest importance that the rotary kiln plant should never be stopped, for a stoppage

will mean cooling down of the kiln and serious interruption, and also damage to the firebrick lining.

Wet Process Plant. We shall take a typical installation to describe the process, just as we did in the dry process plant.

In 23 and 24 we show a large modern wet process plant. The raw materials are ordinary white chalk, containing about 25 per cent. of water in the state in which it is quarried, and gault clay, which also contains 25 per cent. of water on an average.

The raw materials are brought in on rails (1), passing the weighing machines (2), where each waggon-load is brought up to a standard weight by taking off or adding to it from a small store of raw material always at hand in the weighing-house. The weights are made up so as to correspond exactly to the proportion in which the two materials have to be mixed. They are tipped into the three wash mills (3). These are large-sized wash mills, about 25 ft. in diameter. The washing is done with the least possible quantity of water, and the slurry contains only about 33 per cent. of water to 67 per cent. of raw material. The slurry from the wash mills is pumped by three double-acting plunger pumps (4) through a system of pipes distributing the slurry evenly to the two "wet tube mills" (5). Each of these takes a charge of 10 tons of flint pebbles. The quantity of slurry which passes through these tube mills is very considerable, amounting to more than 400 tons a day.

Travels of the "Slurry." The tube mills discharge the slurry into six large triple mixing basins (6), each of which is capable of holding about 200 tons of slurry, and fitted with three systems of agitators; they consist of vertical shafts, with "channel iron" arms revolving slowly, so as to keep the whole contents of the basins in constant movement.

The purpose of the basins is partly to mix large quantities of slurry, so as to do away with any variations in the composition of the slurry as it comes from the wash mills, and partly to provide a means of checking its composition. As a basin fills gradually, the chemist will watch it, and, if necessary, see that more clay or chalk is added to the wash mill from which the basin is being filled. When this is accomplished the contents of the basin are kept in movement until required. In this way the basins act as reserves of slurry, so that there is no need to stop the rotary kiln plant should any breakage occur in the wash mills.

Each of the basins is provided with a slurry pump (7). All of them pump the slurry through a system of pipes ending in a standpipe (8), from whence the six kilns are fed with slurry through valves (9) and shoots (10).

To ensure that the pressure under which the slurry flows into the kilns may remain constant, and the flow consequently regular, the standpipe (8) enters into a small tank (10), with an overflow (11) which leads back into a system of pipes, through which the overflow can be returned to any one of the six basins.

The Kilns. The six rotary kilns (12) are of the usual construction, the upper end being enclosed in a brick chamber, allowing the draught to sweep back outside the shell of the kiln before it goes away to the chimney to increase the drying capacity of this end of the kiln.

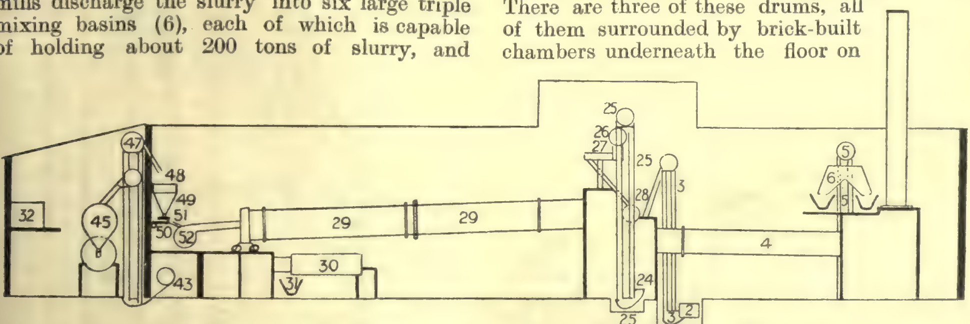
These kilns are 30 metres, or about 100 ft. long by 2·1 metres, or about 7 ft. in diameter.

From the lower end of the rotary kiln the hot clinker falls into the clinker cooler (13), shown by dotted lines under the kiln. This is of the usual type, with two cylinders, one inside the other. The cooled clinker falls into tip waggons on a system of rails (14), and is taken away to the cement store and mill.

Coal Dust Plant. The coal drying and grinding plant are of the usual construction, such as we have already described. The coal drying drums (15) are shown by dotted lines. There are three of these drums, all of them surrounded by brick-built chambers underneath the floor on which the burners work the kilns. The coal is fed in through three "jaw crushers" (16), one for each of the drying drums, and thence lifted by the three elevators (17) into the feeds of the drying drums.

The dried coal is lifted by the two elevators (18) into the two kominors (19), the coal from the outside drying drum being conveyed to the elevator by the worm (20).

The Kominors. The two kominors for coal are a size to take 1 ton 4 cwt. of steel balls, are provided with screens of about 20 meshes to the lineal inch, and discharge the coal direct into the two underlying tube mills (21), where the fine grinding takes place. These mills take a charge of 10 tons of flint



21. ELEVATION OF A DRY-PROCESS CEMENT MILL, SHOWING ONE KILN AND DRYING DRUM

pebbles. The finished coal dust is elevated direct from the tube mill outlets by means of the elevators (22) into the two distributing worms (23) over the six coal dust bins (24).

The small blast fan (25) provides the blast for the injectors into which the coal dust is fed by the variable speed extracting worm in the bottom of the coal dust hoppers. The large fan (26) draws the air through the clinker cooler, the chamber in which the coal dryer is arranged, and blows the hot air into the kiln through the pipe (27) surrounding the coal blast pipe, as described previously.

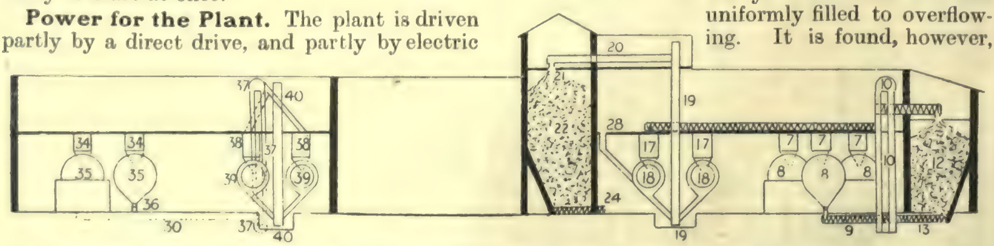
Precautions for Continuous Working. It may be stated here that it is of the greatest importance to be able to run the rotary kilns practically without stoppage. For this reason, all the auxiliary machinery is made amply large enough. Two wash mills of the size given would, under usual circumstances, be sufficient for the quantity of slurry required, and the third is introduced purely as a reserve. One tube mill would be almost sufficient for the quantity of slurry to be ground, but another one has been introduced, so as to be on the safe side, and, as a rule, both work so as to ensure the greatest possible fineness of the slurry.

For the same reason the coal mill plant is made larger than appears necessary ; one tube mill should, under ordinary circumstances, be sufficient to produce the necessary quantity of coal dust, and the other one is practically a stand-by. For the same reason all elevators and distributing worms over the coal dust hoppers have been doubled, so that if anything happens to one, there will be another always ready to start at once.

Power for the Plant. The plant is driven partly by a direct drive, and partly by electric motor. Two steam engines are used, of the same size and construction, each of them provided with a dynamo to supply current to drive the rotary kilns and coal mill plant and pumps by electric motors. Each of them is connected with the main driving shaft which drives the wash mill plant.

Either of the machines can be connected to the main driving shaft. The pumps can be driven either by electric motors or direct from the main driving shaft. In this way every possible provision is made for working the rotary kilns uninterruptedly at all times.

If any larger repairs are necessary, they will, as a rule, be made by stopping the works once a year for a few days, and putting everything into thorough order.



22. ELEVATION OF DRY-PROCESS CEMENT MILL, SHOWING KOMINORS, TUBE MILLS, AND SILOS

The arrangement of the milling plant for grinding the clinker is of much the same nature as described before in the dry process plant.

Composition of Portland Cement. We have already emphasised the importance of seeing that the ingredients, whether chalk, limestone, or clay, are in exactly the right proportions. We must take every precaution to avoid leaving any free lime in the finished cement. Lime particles would not readily slake, and the cement would be unsound ; on the other hand, the amount of lime present should approximate as nearly as possible to the maximum amount allowed, and this limit is approached so closely in modern cement-making that it requires only a very little variation in the proportions of the raw materials to raise the percentage of lime to a dangerous excess. Where lime is burnt in the old-fashioned kilns it becomes mixed with a considerable amount of ash from the coal. This ash is essentially of a silicous nature, and as it combines with some of the lime to form calcium silicate, we can in such cases allow rather more lime than the theoretical amount required by the clay. On the other hand, in the rotary kilns a comparatively small quantity of ash is mixed with the ingredients, much of the fine dust being carried off in the air blast, so that in this case the proportion of lime is kept down to the ordinary limit.

Control Tests. We have explained how quantities of chalk, clay, or limestone are measured off on automatic machines, but it is more usual in the Thames and Medway districts to use all chalk by measure and clay by weight. Chalk is delivered in trucks always of the same size and uniformly filled to overflowing. It is found, however, that the clay is best weighed in the trucks in which it is delivered, and by keeping count of the number of trucks emptied into the mill the proportions can be easily regulated.

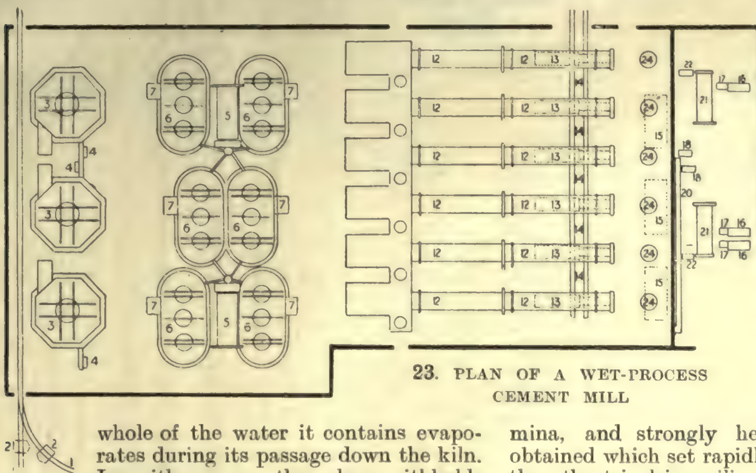
The mixed materials should always be tested by a chemist before taking to the kilns. As the mixture is stored in large reservoirs holding as much as 1,200 tons of slurry, any slight variations in the material tend to equalise themselves.

In testing slurry the amount of carbonate of lime is estimated, and it is usually found that the slurry as it leaves the reservoir does not vary to the extent of ½ per cent. The amount of calcium carbonate is tested chemically by means of some form of calcimeter. The principle of this apparatus depends on the evolution of carbon

dioxide gas when calcium carbonate is treated with an acid. A certain quantity of the slurry is put into a closed vessel and treated with a small quantity of mineral acid sufficient to decompose all the chalk or limestone contained in it. The carbon dioxide gas given off is collected and measured.

Chemistry of Cement Making. We have already explained that, under the action of the great heat developed in the kiln, certain substances known as silicates and aluminates of calcium are produced. We will trace briefly the formation of these substances.

When the materials are fed into the kiln, any water still held is driven off. Of course, if we use wet slurry direct in a rotary kiln, the whole of the water it contains evaporates during its passage down the kiln. In either case the clay withholds some water very tenaciously, and a temperature of 600° C. is necessary to drive this off completely. As the mass sinks into a hotter zone in the kiln, or passes further down the rotary kiln, the carbonate of calcium, whether of chalk or limestone, gradually loses its carbon dioxide and is converted into caustic lime before it reaches a temperature of 900° C. After this, the lime begins to react with the clay, and certain fusible substances, traces of alkaline silicates and aluminates of calcium are produced. The melting of these substances helps to bring the remainder of the lime into contact with the silica. This results in the formation of calcium silicate, which is the essential hardening constituent of the cement, but is not itself fusible in the kiln. The temperature is not uniformly high enough to fuse the whole mass and render the reaction between the constituents complete, but should any free lime be there, there will certainly be the correct proportion of clay to react with it. There is no danger of free lime rendering the cement unsound, provided that it is not present in excess, and that the clinker has been thoroughly burnt.



23. PLAN OF A WET-PROCESS CEMENT MILL

Chemical Research. A great deal of research work has been done on cements with a view to finding out in what way the elements which form the constituents are combined with one another, and what chemical substances are present in the finished cement. Most of the work done in this direction we owe either to Le Chatelier or to two American chemists, S. B. and W. B. Newberry. The latter investigators succeeded in preparing definite aluminates and silicates of lime by fusing together alumina and lime and silica and lime in certain proportions. They nvestigated the properties of the resultant compounds, and came to the conclusion that lime could be combined with silica in the proportion of three molecules to one, giving a product of constant volume and good hardening properties, although the hardening was a very slow process. If, however, they increased the proportion of lime to three and a half molecules as against one molecule of silica, the resultant product was unsound, that is to say, it cracked on setting in water. They thus isolated the tricalcium silicate ($3CaO \cdot SiO_2$) and showed that it is capable of accounting for the hardening of Portland cement.

Lime and Alumina. As for the combination of lime and alumina, they found that when mixed in a proportion of two molecules of lime to one of alumina, and strongly heated, a product was obtained which set rapidly—much more quickly than the tricalcium silicate. This substance we shall term dicalcium aluminate ($2CaO \cdot Al_2O_3$). As the volume remains constant when gauged with water and allowed to set, its presence in Portland cement would account for the rapid setting, and also partially for the subsequent hardening. On increasing the amount of lime to two and a half molecules to one of alumina, the product obtained was not sound. Hence they concluded that to obtain a satisfactory cement the quantities of the ingredients must be so chosen that for every molecule of silica there are three molecules of lime, and for every molecule of alumina two molecules of lime, or, put otherwise, the percentage of lime should equal the percentage of silica multiplied by 2·8 + the percentage of alumina, multiplied by 1·1. This formula agrees pretty well with the results of analyses of numerous Portland cements manufactured in the ordinary way. The exact proportions used in practice depend on the method of manufacture, the purity of the clay, chalk or limestone deposits, and the care exercised in burning, and it is found that good cement will contain anything between 58 and 67 per cent. of lime. All cements contain a small quantity of oxide of iron, and it is a moot point whether this may or may not be regarded as replacing some of the alumina. Some authorities reckon the alumina after deducting the oxide of

iron ; others neglect the latter in their calculations.

Analysis of English Portland Cement. We give below an analysis of English Portland cement, made from chalk and clay :

Silica (SiO_2)	22·04
Alumina (Al_2O_3)	7·35
Oxide of Iron (Fe_2O_3)	4·14
Lime (CaO)	61·94
Magnesia (MgO)	0·91
Soda and Potash (Na_2O. K_2O)	0·59
Sulphuric anhydride (SO_3)	1·38
Moisture and carbon dioxide (H_2O. CO_2)	1·65

Portland cements all the world over do not differ much in composition. Besides the three chief constituents, lime, silica, and alumina, there is always some oxide of iron, usually between 2 and 5 per cent., a trace of magnesia, usually not exceeding 2 per cent., and traces of other substances. The sulphuric anhydride should not exceed 2 per cent. As sulphate of calcium is sometimes added to prolong the time taken by the cement to set, and as its amount is usually limited by agreement to 2 per cent., the raw materials should be as free as possible from sulphates.

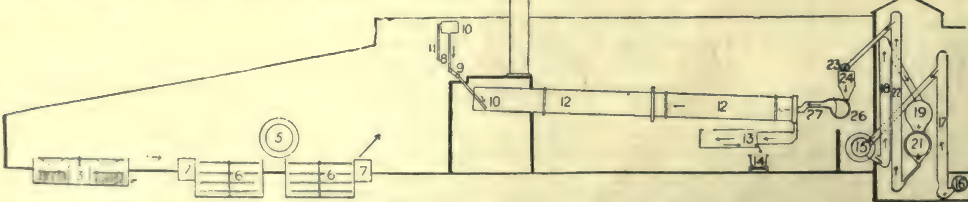
25. MOULD FOR MAKING CEMENT BRIQUETTES

Testing Cements by Chemical Analysis. Cements are very frequently analysed in the laboratory, to see if their composition is within the limits found compatible with a good cement. Thus, if the lime be found to exceed 67 per cent., we should probably reject the consignment as over-limed, or we should be very suspicious as to its durability. The engineers' specifications often fix a limit to the proportion of lime ; thus, for instance, we might specify that the cement in question should contain at least 60 per cent. or not more than 62 per cent. of lime, but in order that our results may not mislead us, we must be careful to see that the sample is dry and has not been unduly exposed to air. The percentage of the ingredients changes a little if cement be spread out so as to expose a large surface to the atmosphere ; this is owing to the absorption of small quantities of carbon dioxide, and moisture which reduces the apparent quantity of lime present.

As the clinker manufactured by the rotary process is more free from ash, the percentage of lime is found somewhat higher than in clinker prepared in the stationary kilns. Moreover, the reaction in the rotary kiln is more uniform, and there are no unburnt or partially burnt lumps of clinker. It is, therefore, possible to work nearer the limit—that is to say, with a higher percentage of lime than in the older process—with the result that a rather better class of material is produced.

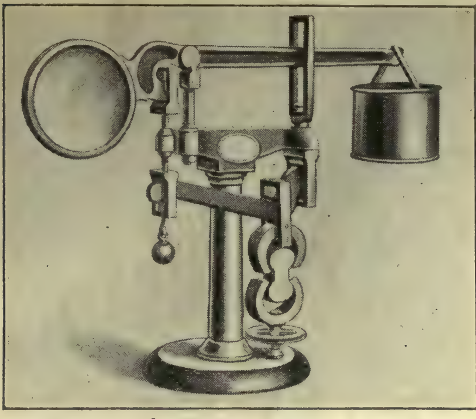
In the Laboratory. When the sample of cement comes to hand it is carefully preserved in an airtight bottle or tin, so that it cannot absorb anything from the atmosphere. If a chemical analysis is to be made, there are several modifications of the ordinary analytical methods which can be used to advantage. For most purposes it is sufficient to decompose a weighed quantity of the cement with hydrochloric acid, care being taken to see that the cement is first very finely ground. If necessary, a small quantity should be re-ground in an agate mortar before starting the analysis. After decomposing with hydrochloric acid, assisted by a few drops of nitric acid, the contents of the basin in which the operation is carried out are evaporated to dryness and " baked," to render the silica insoluble. On adding hydrochloric acid, the silica separates out, and is filtered off and weighed in the usual manner [see ANALYTICAL CHEMISTRY]. There remains in solution as chlorides the iron, aluminium, and calcium. Excess of ammonium chloride and ammonia precipitates the iron and alumina together as hydroxides. For many purposes it is not necessary to separate them, and it is sufficient to filter off the precipitate, ignite, and weigh it.

Detailed Analysis. If the amount of iron and alumina be required separately, it is better to determine the iron by itself in a fresh sample by some other method, and deduct its weight from the weight of the iron and alumina taken together, which will give the quantity of alumina. We have now determined the proportion of all the chief constituents, with the exception of the lime, which we now have in solution. To estimate its amount, it is better to precipitate it in ammoniacal solution by adding an excess of ammonium oxalate, which deposits the lime as calcium oxalate. This is collected on a filter paper, and washed thoroughly with hot water.



24. ELEVATION OF A WET-PROCESS CEMENT MILL

It may be estimated by a number of methods, for which we refer the reader to Analytical Chemistry. It is often necessary to estimate the amount of sulphuric acid to see if an excess



26. BAILEY'S CEMENT TESTER, SHOWING BRIQUETTE IN POSITION

of calcium sulphate or gypsum has been added to the cement. For this purpose we may take a filtered solution in hydrochloric acid of a fresh sample of cement, and determine the sulphuric acid by precipitating as barium sulphate in the usual manner.

Results of Chemical Analysis. The percentage of lime is not always a guide to the soundness of the cement, as a thoroughly burnt cement will stand a greater percentage of lime than an imperfectly burnt one where the temperature has not been sufficiently high to bring about complete combination of the lime and silica. It is not possible to determine the amount of uncombined lime by ordinary chemical analysis, so that its presence is only indirectly inferred by the behaviour of the cement under another test—*viz.*, that for soundness—which we shall describe later.

If the raw materials are not thoroughly ground and intimately mixed there may be incomplete chemical combination, and consequently free lime in the cement, although the percentage shown by analysis is not higher than in an average good sample.

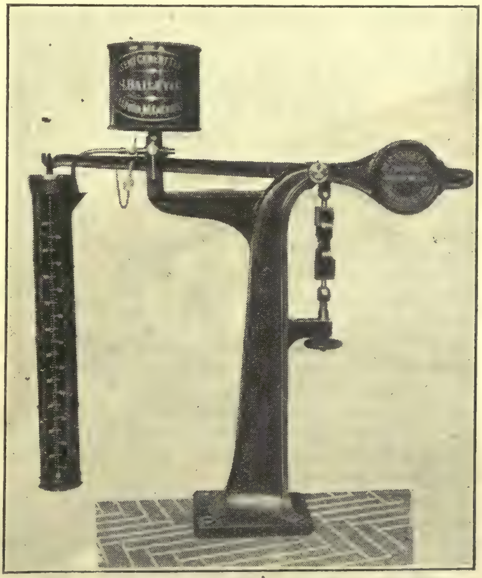
The amount of alumina in cement may be anything between 5 and 10 per cent. As a rule the greater the proportion of alumina the quicker the "set," and the setting may be so rapid as to render it useless for many purposes. Calcium aluminate has not the peculiar hardening qualities of the silicate, so it stands to reason that with too much alumina the strength of the cement will be reduced.

All cements contain more or less iron, which is shown in the analysis as ferric oxide, although it exists in the cement in the ferrous state. The amount does not usually exceed 5 per cent., and is not regarded as harmful if kept within this limit.

Causes of Colour. The cement owes its grey colour to the iron it contains. If the cement were free from iron it would be white, so that, as in the case of bricks, the colouring is brought about by the iron present, and will vary in intensity with the amount.

As to magnesia, opinions seem to differ a good deal as to what percentage should be allowed. Many of the natural rock cements contain very large proportions of magnesia, while, on the other hand, many people object to a Portland cement containing 2 or 3 per cent., or, at most, 5 per cent. It is generally considered that the presence of magnesia tends to cause the cement to crack. The amount of alkalies should be small. They probably do not play such an important part in the manufacture of cement as was at one time generally supposed. Some cements made from alkali waste naturally contain large quantities, but a good sample of Portland cement should not contain more than 2 or 3 per cent. Usually it will be less than 1 per cent. We have already explained that gypsum is added in small quantities to get a slower setting cement, and that, in consequence, the amount of sulphuric acid is limited to 2 per cent. There seems to be no doubt that anything over 5 per cent. of calcium sulphate is injurious.

Cements usually contain traces of carbonates. Of course, if there is any quantity present, it will point to an imperfectly burned cement; but cements prepared in this country are frequently exposed to air for a fortnight or so, in order that any trace of free lime may be



27. BAILEY AND REID'S CEMENT TESTER, BUILT WITH ONE LEVER

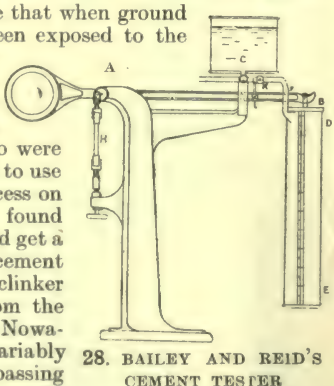
rendered harmless by taking up carbonic acid with the formation of calcium carbonate. The amount of carbonic acid absorbed in this manner will seldom exceed 1 per cent.

"Setting" of Cement. We must emphasise again the distinctions between the setting and the subsequent induration or hardening of cement. The test is usually carried out by mixing a small quantity of the cement with only just sufficient water to make it a uniform paste.

The pat is mixed or "gauged" as quickly as possible, and thrown on to a glass plate, so that it forms a mass 2 or 3 in. wide and, say, ¼ in. thick. It is then tested with a weighted needle applied to the surface every now and again, until it no longer makes an impression. The needle weighs 2¼ lb., and is provided with a square point, measuring $\frac{1}{10}$ inch each way. Although sufficient water must be taken to produce a plastic mass, an excess of water must be avoided, as the time taken to set will in that case be much altered.

Atmospheric Influence. The temperature and humidity of the surrounding atmosphere influences considerably the rate of "set." These conditions should be kept as constant as possible. A good temperature to take is that of 60° F., or 15° C., which is the ordinary temperature of the laboratory. The atmosphere should be moist, so that the water does not evaporate from the pat while it is setting. This is a point of much importance in slow-setting cements, which may take an hour or more to set, and the pats should be covered over to prevent evaporation.

With the increasing degree of fineness to which cements are nowadays ground, manufacturers have had some difficulty in producing a quality that would not set too fast. It has been known for a long time that when ground cement has been exposed to the atmosphere in thin layers it takes longer to set. The Americans, who were among the first to use the rotary process on a large scale, found that they could get a slower setting cement by wetting the clinker as it came from the clinker cooler. Nowadays, this is invariably effected by passing steam into the tube mill used for grinding the clinker. It is found that by carefully regulating the quantity of steam admitted the rate of "set" can be very efficiently controlled.



28. BAILEY AND REID'S CEMENT TESTER

How Fine is Cement Ground? Not very many years ago manufacturers were content to produce cement sufficiently finely ground not to leave more than 15 per cent. residue on a 50-mesh sieve. Nowadays a residue not exceeding 15 per cent. on a 180-mesh sieve is the usual standard. When we speak of a 50-mesh sieve, we mean one in which you may count 50 wires to the lineal inch, and as there will be another 50 wires crossing these to make one square inch of the wire gauze, there will be 50 × 50, or 2,500 holes altogether in the square inch.

The same considerations apply to 75, 100, and 180-mesh sieves, which are those usually used for testing cement.

The Mesh of the Sieve. Now, the size of the hole in a sieve of any particular mesh will depend upon the thickness of the wire. The thicker the wire, naturally the smaller the holes, so that it is important to use a standard wire in making these sieves. It is so arranged that whatever be the mesh of the sieve, the diameter of the wire shall be just equal to half the space between the wires. Thus, taking, say, a 100-mesh sieve with 10,000 holes, the space in one lineal inch will occupy two-thirds of an inch, and the 100 wires, if placed together, will occupy one-third of an inch, so that the diameter of the wire in a 100-mesh sieve will be $\frac{1}{300}$ inch.

Bamber gives the following figures for the fineness of cement in ordinary practice:

Mesh.	Residue left in sieve.
50 (2,500 per sq. in.)	Trace per cent residue.
76 (5,776 " ")	1 to 2 " " "
100 (10,000 " ")	3 to 5 " " "
180 (32,400 " ")	15 to 20 " " "

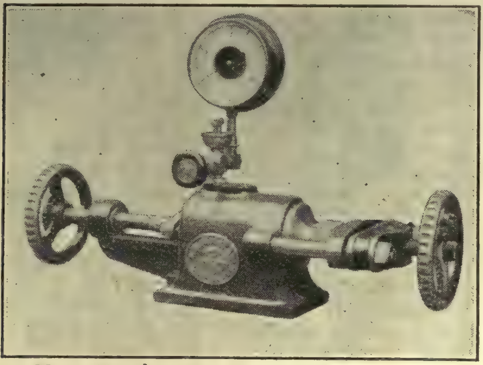
When testing cement in this manner it is usual to take 100 grammes of the cement and to weigh what remains on the sieve, and not that which passes through, as some of the latter, being ground to the finest dust, would be lost.

To make sure that you have got as much as possible of the powder through the sieve, you should tap it while holding it over a clean sheet of paper. Any more powder passing through will then be easily detected. The advantages of a finely-ground cement are self-evident. As it is invariably mixed with sand, the particles of the latter are more completely surrounded by particles of cement when the latter is fine ground. The strength of the resulting concrete or mortar is, in this manner, considerably augmented.

Specific Gravity of Cement. This test is useful in detecting some adulterants. It is found that the specific gravity varies little from the figure 3·125, and should it differ from this, you may suspect the addition of some inert material. As examples of such adulterants, we may mention a rock known as "Kentish rag," which is not unlike cement itself in appearance, but has a much lower specific gravity. It used to be regularly added to cement—in fact, some people asserted that cement was thereby improved. This view is now generally discredited. Ground blast furnace slag is another adulterant which closely resembles Portland cement, both in colour and chemical composition.

Density and Quality. Imperfectly or under-burned cement will be lighter and have a lower specific gravity than properly burned material. The test is usually performed in a specially designed bottle, with a graduated neck, and depends upon the principle that equal weights of bodies of different specific gravity occupy different volumes. This principle is no other than that handed down to us in the

story of Archimedes and his bath. The bottle, which holds 50 to 60 cc., is filled with dry turpentine to a given point marked on the neck. A weighed quantity of cement is then added. The volume of turpentine displaced by the cement will be apparent by the extra volume occupied by the turpentine in the graduated bottle. Two precautions must be observed in making this test; first, care must be taken to see that no air bubbles hang to the particles of cement, but that they are thoroughly "wetted"



29. BAILEY'S CEMENT-CRUSHING TESTER

by the turpentine; secondly, turpentine expands a good deal with rise of temperature, so that the temperature must not be allowed to vary during the experiment. It is best to immerse the bottle and the turpentine in a large vessel of water, at, say, 60° F., until the turpentine attains exactly the same temperature as the surrounding water.

After adding the cement to the bottle, it is again immersed in the same water long enough to enable the temperature to become constant before the next reading is taken.

Testing the Strength of Cement. As cement is usually employed in admixture with sand in the form of mortar or concrete, it is usual to test the strength not only of the neat cement, but of cement mixed with three parts of sand. We may either determine the power required to crush a block by compressing it, or break it by pulling it in two. Although the former method corresponds better to the conditions to which cement is exposed in practice, it is a more difficult operation to carry out than the latter method—testing tensile strength—so that most of the testing machines and the cement specifications are based on, and apply to, the tensile strength. For this purpose, a weighed quantity of cement is gauged with as small a quantity of water as possible, and filled into a mould shaped in outline somewhat like a dumb-bell [25]. The mould is first slightly greased to prevent the cement from sticking as it sets. A number of moulds are similarly filled up with cement, for which it is better to gauge each lot of material separately. The moulds are made of definite size and dimensions, so as to give uniform results.

When set, the "briquettes" are taken out of the moulds and tested under different conditions. A special sand from Leighton Buzzard is used for making mixtures with cement, or else crushed quartz, and of such a degree of fineness that the whole will pass through a 20-mesh sieve and be retained by a 30-mesh sieve.

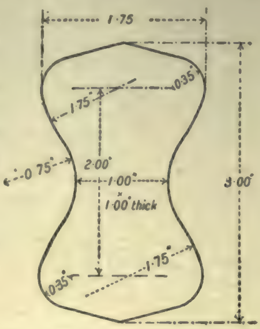
The Testing Machines. When the briquettes have set they are immersed in water for 24 hours before testing. Others are kept 7 days and longer. It is usual to have several briquettes and test them regularly at different intervals. Although the narrowest part of the briquette is frequently only 1 in. across, the power required to break such a briquette is considerable. The instrument used is made up of either a single lever or a combination of levers. The block is held between clips [26], and, by means of a double lever great force is applied. The two levers are situated one over the other. It is essential that the power be applied regularly, and this is done by running either water or small shot at a regular rate into a pan hanging at the end of the second lever. The instrument shown in 26 works with shot. By an automatic arrangement, not shown in 26, the supply of shot is cut off directly the briquette breaks. The can full of shot is then taken to a balance and weighed. By multiplying this weight by the ratios for the leverage we obtain the power required to break the briquette under examination. Thus, the leverages may be 5 to 1 and 10 to 1, so that the total leverage will be 50 to 1; hence the weight of the can with water or shot must be multiplied by 50 to give the tensile strength of the briquette. A good average sample of cement will give figures somewhat as follows:

TENSILE STRENGTH NEAT				
1 day	7 days	14 days	28 days	6 months
Av. 204 lb.	462 lb.	485 lb.	553 lb.	754 lb.

ONE PART CEMENT TO THREE PARTS SAND			
7 days	14 days	28 days	6 months
Av. 116 lb.	125 lb.	163 lb.	268 lb.

Figs. 27 and 28 show Bailey & Reid's machine for testing the tensile strength of cement. It is built with one lever AB [28] instead of two, and the strain is applied by running water from the small cistern C into the long graduated can DE. In this manner the strain is increased gradually and in a very regular manner without any vibration. When the briquette shown at H breaks, and the end B of the lever begins to sink, the supply of water to the can is cut off automatically at K by the attachment or trigger L. To read the instrument it is simply necessary to note the height of water in the can DE, for which purpose it is fitted with a gauge-glass and graduated.

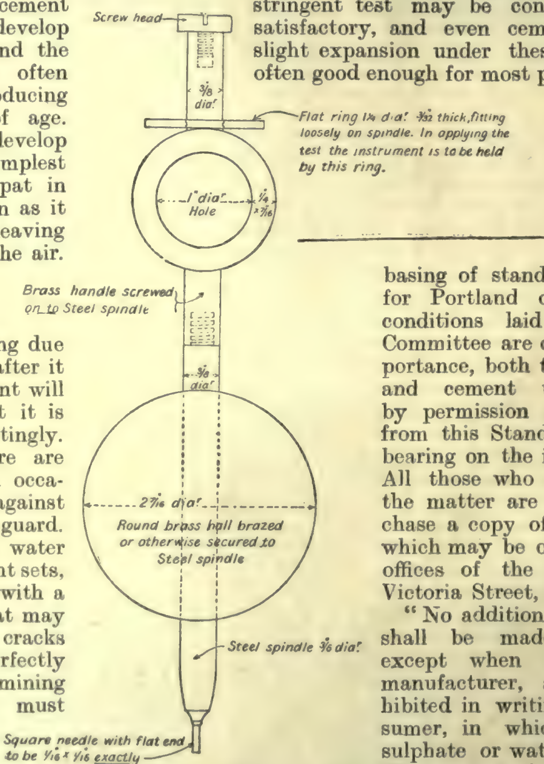
Fig. 29 shows an apparatus for testing the resistance of cement to a crushing strain. The small block is inserted in position, as may be seen in the illustration. Hydraulic pressure is applied by a piston actuated by the hand wheel at the further end of the apparatus. The pressure is read on the gauge on the top of the instrument. The blocks of neat cement, or cement and sand, are usually made 1 in. square.



31. STANDARD BRIQUETTE FOR TESTING

Is the Cement Sound? We come now, lastly, to perhaps the most important test of all—the test for soundness.

The tensile strength may be exceedingly high, but, unless sound, the cement is worthless. It often takes some time for cement which is unsound to develop suspicious indications, and the tests for soundness are often designed with a view to producing artificially the effect of age. Some cements rapidly develop faulty qualities, and the simplest test is to immerse the pat in water for 24 hours as soon as it is thoroughly set, while leaving a similar pat exposed to the air. Both pats are carefully examined from time to time to see if there are any indications of cracking due to expansion of the mass after it has once set. If the cement will not stand this simple test it is to be condemned unhesitatingly. On the other hand, there are certain appearances which occasionally mislead, and against which one must carefully guard. Thus, should some of the water evaporate before the cement sets, which may easily happen with a slow-setting cement, the pat may show certain contraction cracks although the cement is perfectly sound, so that in examining slow-setting cements care must be taken to prevent the moisture evaporating before the cement has set by keeping the pats under a cover.



31. SKETCH OF "NEEDLE" FOR ASCERTAINING SETTING TIME OF CEMENT, AS ADOPTED BY THE ENGINEERING STANDARDS COMMITTEE

Exacting Tests. It is usual to apply more stringent tests for soundness. There are many modifications of the method applied, but in principle it consists in placing in water the pats, which have been given time to set, and gradually heating up the water. This will bring out in a pronounced manner any tendency to crack, as any free lime is far more rapidly slaked under these conditions.

When a very stringent test is required, the actual expansion in warm water may be measured by Le Chatelier's apparatus. This consists of a small cylinder of brass split down the middle so as to be elastic. Sufficient cement is gauged to fill the cylinder, which stands upright on a glass plate. It is covered with another glass plate, and left 24 hours to itself. Each side of the split cylinder is provided with a long pointer, and the cylinder containing the cement, which has now had time to set, is placed in water at a temperature of about 60° F., and left for 24 hours. The distance between the indicator points is carefully noted. The water is then gradually heated until it boils, and is kept boiling for 6 hours. After cooling, the distance between the indicator points is again measured, and if any expansion has taken place it will be immediately apparent.

Cement which is capable of standing this stringent test may be considered perfectly satisfactory, and even cements which show slight expansion under these conditions are often good enough for most purposes.

Standard Quality. The Engineering Standards Committee approved a report in December of 1904 for the basing of standard specifications for Portland cement. As the conditions laid down by the Committee are of paramount importance, both to cement makers and cement users, we give by permission some quotations from this Standard Specification bearing on the important points. All those who are interested in the matter are advised to purchase a copy of the full report, which may be obtained from the offices of the Committee, 28, Victoria Street, S.W.

"No addition of any material shall be made after burning, except when desired by the manufacturer, and if not prohibited in writing by the consumer, in which case calcium sulphate or water may be used." The amount of water or calcium sulphate allowed is 2 per cent.

Special precautions are to be taken with regard to the sample, so as to obtain a representative portion of the whole.

Provisions are made for the testing and chemical analyses of consignments of 100 tons or more. In cases of smaller consignments, "manufacturers shall, if required, give a

certificate of each delivery, to the effect that such cement complies with the terms of this Standard Specification."

Grinding for Testing. The cement is to be ground so as to comply with the following degrees of fineness—namely, the residue on a sieve 76 × 76 = 5,776 meshes per square inch, shall not exceed 3 per cent., and the residue on a sieve 180 × 180 = 32,400 meshes per square inch, shall not exceed 22½ per cent.

The sieves shall be prepared from standard wire, and the size of the wire for the 5,776 mesh shall be ·0044 in., and for the 32,400 mesh, ·002 in. The wire shall be woven (not twilled).

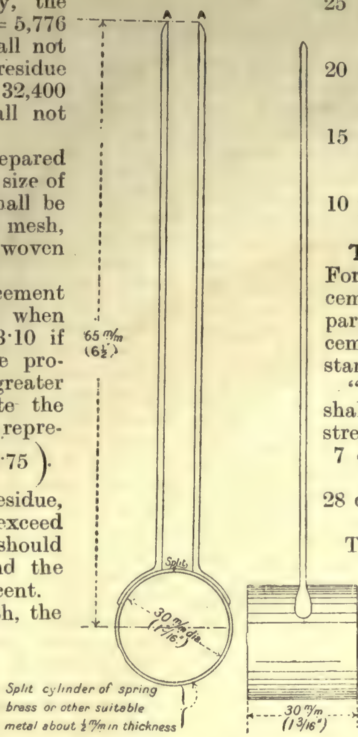
The specific gravity of the cement shall be not less than 3·15 when sampled at the works, or 3·10 if sampled after delivery. The proportion of lime shall be no greater than is necessary to saturate the silica and alumina present, as represented by $\left(\frac{CaO}{SiO_2 + Al_2O_3} = 2{\cdot}75\right)$.

The percentage of insoluble residue, it is stated, should not exceed 1·5 per cent., the magnesia should not exceed 3 per cent., and the sulphuric anhydride 2·5 per cent.

For testing tensile strength, the sample is to be spread out to the air for 24 hours before gauging, and the water used should be sufficient in quantity to form "a smooth, easily worked paste."

The briquette [30] is to be placed "in a damp atmosphere for 24 hours after gauging," after which it is to remain in fresh water until required for breaking.

For testing neat cement "the briquettes shall bear on the average not less than the following tensile stresses before breaking:



32. APPARATUS FOR CONDUCTING THE LE CHATELIER TEST, AS ADOPTED BY THE ENGINEERING STANDARDS COMMITTEE

7 days from gauging .. 400 lb. per sq. in. of section.
28 „ „ „ 500 „ „ „

The increase from 7 to 28 days shall not be less than:

25 per cent. when the 7-day test falls between 400 lb. to 450 lb. per sq. in. of section.
20 per cent. when the 7-day test falls between 450 to 500 lb. per sq. in. of section.
15 per cent. when the 7-day test falls between 500 to 550 lb. per sq. in. of section.
10 per cent. when the 7-day test is 550 lb. per sq. in. or upwards."

Testing Sand and Cement. For testing a mixture of sand and cement the briquettes are to be prepared from a mixture of one part of cement and three parts of dry standard sand.

"The cement and sand briquettes shall bear the following tensile stresses:

7 days from gauging, 120 lb. per sq. in. of section.
28 days from gauging, 225 lb. per sq. in. of section.

The increase from 7 to 28 days shall not be less than 20 per cent."

Quick, medium, and slow-setting cements are thus defined:

"*Quick.* The setting time shall not be less than 10 minutes, nor more than 30 minutes.

"*Medium.* The setting time shall not be less than half an hour nor more than two hours.

"*Slow.* The setting time shall not be less than two hours, nor more than five hours."

The needle for testing the set of the cement [31], and also the Le Chatelier method of testing for soundness [32], both already referred to, are the standard machines adopted by the British Standard Specification.

Cement Manufacture concluded

Group 7 CLERKSHIP 13 Continued from page 1751	THE MODERN CASH BOOK

THE MODERN CASH BOOK

The Two Systems of Bookkeeping. Method Adopted where a Journal is Subdivided. The Cash Book. Monthly Bank Totals

By A. J. WINDUS

THE synopsis already given has preceded the observations and remarks which it was at first intended should accompany it. By this arrangement, an educational objection has been removed. It is unwise to encourage the facile reception of teaching of the kind that carefully forestalls every difficulty, because to do so is to discourage the much harder, but far more precious, habit of independent thought and speculation.

In the absence of premature explanations, readers have had an opportunity of forming their own judgment as to the rival systems of double-entry bookkeeping which have been described. No opinion is worth much, however, which either does not take into account all the facts known at the time, or which distorts one or more of them to bolster up a pet theory. But opinions which have been honestly arrived at as the result of mental toil and fairplay, will possess permanent interest and value for the student, even though they fade away in the light of fuller knowledge, or, at least, need revision. If now we complete our synopsis by adding to it the postponed observations and remarks to which reference has been made above, we shall be enabled to put these opinions in some measure to the test.

The Two Systems of Bookkeeping. Once again, then, we must go through the now familiar list of transactions lettered *a* to *u*, this time with the object of noting and explaining, as they arise, the chief points of difference between the two systems of bookkeeping illustrated in the synopsis. Incidentally, there will be a clearing up of one or two little mysteries concerning those transactions for which, in the modern system, the double entry has hitherto appeared to be lacking.

Transaction (*a*). Cheque £5, drawn for petty cash. Here, on the very threshold of our subject, we discover a remarkable divergence between the old system and the new. Where the former has been preserved in its integrity, all cash items are journalised prior to being posted one by one, first to the cash account, and then to the personal accounts in the ledger. For sheer waste of time in the fatuous assumption that there is no better plan, this method is hard to beat, and has, moreover, done much to render the old-fashioned bookkeeping laborious to a degree that almost surpasses belief. There is a forcible illustration of this in transaction (*d*). Mr. Allday purchased for cash goods value £1 5s. 9d. Dealing for the moment with the cash alone, we first debit cash account because the money comes in, and credit Allday the giver. Next, we credit cash account because the money goes out, and debit the bankers, because they receive it. After this, we proceed to post up the accounts of cash, bank, and Allday (or cash sales) respectively.

Cash a/c v. Cash Book. Still considering the cash amount of £1 5s. 9d., we notice that this is repeated four times in the journal and four times in the ledger, or eight times in all; while under the modern system one amount in the cash book [see diagram, page 1751], and another in the ledger, suffice for all purposes.

Small wonder, then, that in many quarters where the desire to abolish or curtail needless labour co-exists with a reluctance to surrender the old-style journal a compromise has been effected, whereby the distinctive features of the journal have been retained unaltered, except that cash and discount items are rigidly excluded therefrom, being entered directly into the cash book, from whence they are posted to the ledger.

But this reform, while it relieved the overburdened journal of a mass of detail which could be dealt with to better advantage in the cash book, wrought a curious change in the character of the cash account itself.

Considerations of space forbid any sort of chronological treatment of our subject, and, therefore, we shall not enter upon an inquiry as to the time when the custom of writing up the cash account from the journal into a special book, instead of, as formerly, into the ledger, became prevalent. But this much is certain. As long as the cash account derived its component items from the journal in the same way as any other ledger account, so long was it entitled to be regarded as a part of the ledger, even though it was contained in another book. But as soon as the cash book assumed functions hitherto exercised by the journal, in other words, as soon as it became a book of original entry, it ceased to be a part of the ledger, and was in reality a journal. Now, the true conception of a journal is that of a book in which each day's transactions are entered in due form for posting to the ledger, and the words "in due form" signify that the entries must be so arranged as to ensure that the money totals of the debits and credits journalised and posted shall equal one another. We observe that this is the case in the example before us where the debits and credits of the journal each total £469 15s. 2d., and that the debits and credits in the ledger epitome which formed part of the synopsis also severally aggregate £469 15s. 2d.

Classified Transactions. But where the journal is sub-divided, separate books being devoted to special classes of transactions, it is unnecessary to set out every entry in debit and credit form. It is sufficient if one term

of each equation is recorded, care being taken to see that the terms are either all debit or else all credit. The equalisation of the debits and the credits is performed at stated—usually monthly—intervals, and resolves itself into a question of correctly casting the debits (or credits) previously entered and posted to their several accounts. The double entry is completed by posting the total ascertained as above to some account in the ledger on the opposite side to that to which the details have been carried.

We could not have a better illustration of this principle than is afforded by the day book shown on page 978. The total sales for September, 1905, are there stated as £791 16s. 2d. As a matter of fact the amount includes sundry charges for foreign parcel-post, but for present purposes this element may be neglected. The figures between transverse lines in the margin of the day book refer not to the accounts in our ledger epitome, but to the folios in Messrs. Bevan & Kirk's Sold ledger, where the respective accounts of Springer, Bruce, and Aird Bros. are to be found. In like manner the three ledger accounts will each contain a reference to D.B. 355.

It needs but a glance at the day book to see that the entries are not set out as in the old-style journal—that is to say, in debit and credit form; but at the same time it is quite clear that if all the September day book debits posted separately to the sold ledger amount to £791 16s. 2d., the requirements of double-entry are sufficiently complied with by posting that amount *in total* to the credit of the sales or goods account in the ledger. We may remark in passing that in actual practice it would be advisable to split the total of £791 16s. 2d. into two amounts—the one representing sales and the other the various sums charged for postage of goods to places abroad. If the total postage amounted to £3, then £3 should be posted to the credit of trade expenses account, because that account was debited with the sums paid out in the first instance from petty cash in this connection. The balance of £788 16s. 2d. should be carried to the credit of sales account.

The Debit Side of the Cash Book. Having demonstrated the principle that the total debit for a given period in a book of original entry demands an equal credit, and vice versâ, let us apply that principle to the cash book. We find on page 779 a specimen folio of Messrs. Bevan & Kirk's bank cash book. First let us examine the debit side.

Bearing in mind what has already been said on the subject, we shall experience little difficulty in arriving at the following conclusions: (*a*) Since all receipts of cash are lodged regularly at the bank without deduction, whatever moneys are credited to customers' and other accounts should simultaneously be debited to the bankers. (*b*) This process, if carried out, would constitute perfect double-entry, and there would be no object in keeping a separate cash account as distinguished from a petty cash account. (*c*) The entries in the bank column are in the form advocated for specialised books of original entry—that is to say, every item furnishes one term of an equation:

Bank Dr. to Customer.

(*d*) The several items being posted in detail to the *credit* of the various personal accounts, the debit is derived from the total of the bank column, £514 16s. 11d., less the balance as at September 1st, say £50. The double-entry is, therefore, completed by posting £464 16s. 11d., which represents the actual amount of cash received during September, to the debit of bank account in the ledger.

The items in the discount column (Dr. side) are similarly treated, except that there is no starting balance to take into account; thus the details composing the total of £9 3s. 0d. are posted separately to the various personal accounts, while the total itself is carried to the debit of the discount account.

The Credit Side of the Cash Book. Coming now to the credit side of the cash book, the discount items will be posted to the debit of the personal accounts affected, while the total of £13 9s. 9d. must go to the credit of discount account.

The amounts appearing in the bank column (Cr. side) represent cheques drawn by Messrs. Bevan & Kirk on their bank, and paid away to different persons who are debited, the bankers being simultaneously credited. But whereas the debits must be posted separately, it will suffice to post one credit to the bank account for cheques drawn during the month, the amount of the credit being derived from the total of the bank column, £514 16s. 11d., less £34 5s. 1d. balance carried forward—that is, the cheques drawn in September, plus the bank charge for discounting Wake's acceptance, totalled £480 11s. 10d.

Dr.	Bank a/c			£	s.	d.		Contra			£	s.	d. Cr.
1905							1905						
Sept 1	To Balance	b/f		50	.	.	Sept 30	By Bank charge				3	.
30	" Lodgments			464	16	11		" Cheques drawn			480	8	10
								" Balance	c/d		34	5	1
				£514	16	11					£514	16	11
Oct 1	To Balance	b/d		34	5	1							

Bank Accounts in the Ledger. Here is an illustration of the bank account in the ledger. The commencing balance of £50 has been brought forward from August 31st in the same way as the balance as at September 30th has been carried forward to October 1st. The debit of £464 16s. 11d., and the credits of 3s. and £480 8s. 10d., are authorised by journal entries as follows :

27 Journal

1905				£	s.	d.	£	s.	d.
Sept	30	Bank Dr	GL4	464	16	11			
		to Sundry Debtors	CB45				464	16	11
		Cash received and paid into Bank during month							
		Trade Expenses Dr	CB45		3				
		to Bank	GL4					3	
		Charge for discounting Wakes acceptance							
		Sundry Creditors Dr	CB45	480	8	10			
		to Bank	GL4				480	8	10
		Cheques drawn during month							

Some bookkeepers consider the bank account in the ledger superfluous, because it is simply an epitome of the figures contained in the bank columns of the cash book. In other words, the bank account is already in the cash book in detail, and does not need a place in the ledger. Where the bank balance is carried forward month by month in the cash book, as in the example before us, it is true that the bank account might be omitted from the ledger without much harm being done. But there is something to be said in favour of having *every* account in the ledger, and the extra time expended in securing this result will not be wasted. Sometimes the balances are not shown in the cash book, and then it is imperative to have a bank account in the ledger. In such case the bank columns in the cash book are totalled monthly and ruled off without being equated, and the totals are posted to the ledger direct. Had this plan been adopted in our example on page 779 the debit total would have amounted to £464 16s. 11d.—actual receipts during September, and the credit total to £480 11s. 10d.—actual payments for the same period. After the direct posting of these items the bank account in the ledger would, of course, show the same balance as it did when the lodgments and drawings were first journalised and then posted.

Application of Principles of Double-Entry. Although the principles of double-entry are inflexible, nothing is more elastic than the method of applying them in given cases. For instance, if it be objected that a bank account in the ledger is useful, but that it takes too long to journalise the monthly totals in the manner described, the answer is that this is desirable but not essential. Reverting to the bank cash book on page 779, we can if we please split the columnar totals thus :

Dr.		Cr.	
Balance 1st Sept.	50 0 0	Bank charge -	3 0
Lodgments -	464 16 11	Drawings -	480 8 10
		Balance carried forward -	34 5 1
	£514 16 11		£514 16 11

The best place for these new figures is : debits immediately beneath the discount total on the Dr. side, credits immediately beneath the discount total on the Cr. side.

We may now post the lodgments total direct to debit and the drawings total direct to credit of bank account in the ledger, marking in the cash book folio columns the ledger folio occupied by the bank account, marking also in the folio columns of bank account the cash book folio from which the posted items have been copied.

Cross References. Particular attention is directed to the cross-references here mentioned—namely, the references in cash book to the ledger folio and the references in bank account to the cash book folio. Every

ledger posting should reveal its place of origin, and every entry in a cash book or other journal should reveal its station in the ledger. Folio columns, annexed to the money columns, are provided for the purpose in the vast majority of account books, and it seems absurd that anyone should find difficulty in adopting a system of mutual reference which is as simple as it is efficacious.

We will return to our dissected figures for the bank columns in the cash book. The lodgments total having been posted to debit of bank account, the drawings total will go to credit of same account, as will also the bank charge of 3s. But with regard to the commencing balance of £50, and the ending balance of £34 5s. 1d., these amounts cannot be posted to the ledger, as they are contras to equivalent amounts appearing elsewhere in the cash book. Thus the debit of £50, with which September starts, is offset by the credit of £50, with which August ends. The two amounts explain and justify each other. The very condition of their existence is that they shall take opposite sides to one another, so that the credit of £50 cannot be created unless a debit of equal amount be created at the same time, thereby vindicating the primary law of a debit for every credit. By the same rule the ending balance of £34 5s. 1d., which at September 30th is carried forward on the credit side, is brought forward on the debit side as at October 1st as the commencing balance for October. It is evident that to post either the £50 or the £34 5s. 1d. to the ledger would be to transgress the law, since the double-entry for both these items has been already completed in the cash book itself. This point is worthy of notice, because the theory involved underlies every "balance" entry made in books of account—that is, every entry the amount of which is preceded by the words "To balance" or "By balance." Consider the account of J. Wake as set out below:

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Dr. J. Wake

1905								
Aug 20	To Goods DB	305	4	7	8			
Sep 1	" do	320	9	8	7			
17	" do	327	6	14	3			
20	" do	341	7	7	4			
						£ 27	17	10
Sep 20	To Balance	b/d				7	7	4

179

Contra Cr.

1905								
Sep 26	By Bill CB	45	20	10	6			
20	" Balance	c/d	7	7	4			
						£ 27	17	10

The rule is that entries cannot be made in the ledger except through the medium of the books of original entry. Thus the first four debit entries in Wake's account are posted from the day book—the first credit entry from the cash book. But in the case of "balance" entries the rule is relaxed of necessity, because a ledger balance is neither a transaction nor a transfer. At all events it is not a transfer in the sense of registering an internal change, for the state of a ledger account is the same after bringing down a balance as before. The presence in J. Wake's account (or the absence therefrom) of balance entries makes no difference to the fact that after the sum of £20 10s. 6d. had been passed to credit of his account there was a balance due from Wake of £7 7s. 4d. We may, therefore, look upon the entry "Sept. 20th. To balance brought down £7 7 4" as amounting to nothing more than a concise declaration of the state of Wake's account on a particular date. The entry tells us that the debits then exceeded the credits by a certain sum, namely, £7 7s. 4d. If we accept this figure as the starting-point of a new account, we virtually promise to close the old account by making a balance entry on the credit side, the amount of which shall equal the new debit. The credit entry: "Sept. 20th. By balance carried down £7 7 4" is in fact our warrant for the contra entry, and the two entries together constitute a double-entry, thus conforming to the established principle of a debit for every credit.

Treatment of Monthly Bank Totals. The journal entries exhibited earlier remain to be dealt with. These are intended to show how the monthly bank totals should be treated where the system prevails of passing all monthly totals from the books of original entry through the Journal on their way to the ledger. With regard to the posting of these entries the effect on the bank account has been explained. "G. L. 4" means that the bank account is on folio 4 of the General ledger. There should be a reference also in the folio columns of the bank account to Journal 27.

In the Journal folio column level with the credit of £464 16s. 11d., there will be found, in place of the usual reference to a ledger folio, a reference to CB. 45. On referring back to CB. 45 we discover the reason for this—namely, that the various items of which the journal credit is composed have been posted to the credit of their respective accounts *from the cash book*. In like manner, the journal debit of 3s., and the several items aggregating the journal debit of £480 8s. 10d. have been posted to the debit of their respective accounts from the cash book. There is therefore no need to post them again from the journal.

How to Test the Balance. Before deserting the bank account, let us see how the accuracy of the balance may be tested by comparison with that shown in the bank pass book. The pass book discloses the state of Messrs. Bevan & Kirk's banking account as it appears from the records of the bank, and not necessarily as shown by the firm's cash book. Naturally enough, the pass-book balance and the cash-book balance seldom coincide. On the one hand, cheques received by the firm are entered in the cash book under date of *receipt*, but they are acknowledged in the pass book under date of *clearing*, which, in the case of long distance cheques—say a cheque drawn on Dublin and remitted to London—would be several days later than the date of receipt by Bevan & Kirk. On the other hand, cheques drawn by Bevan & Kirk are entered in the cash book under date of *issue*, but in the pass book they appear under date of *payment by the bank*.

Delay in presenting cheques for payment frequently occurs, and must be taken into account in trying to agree the pass book with the cash book. A simple illustration of a pass book agreement will now be given. Mr. Kirk obtained the firm's pass book from the bank on October 5th, and found there was a balance of £42 6s. 11d. at credit of the firm on October 1st. Having succeeded in reconciling this balance with that shown in his cash book, he made a red ink memorandum on the cash book thus:

1905.				
Oct. 1.	Balance as per P.B.	42	6	11
	Add cheque not cleared (Jones)	29	8	2
		71	15	1
	Less cheque not presented	37	10	0
	Balance as per C.B.	34	5	1

It is probable that as Mr. Kirk has postponed the checking of the pass-book until October 5th, he will be able to satisfy himself from it that since October 1st the commission cheque from Jones has been duly cleared and the rent cheque duly presented and paid, but that does not affect the position as at October 1st with which he is at the moment concerned.

Continued

RUNNING, LEAPING, & CLIMBING ANIMALS

Continued from page 1765

Hoofed Mammals. Comparison of the Bones of the Hand. Kangaroos. Moles and Monkeys. The Value of the Tail. Man's Origin

By Professor J. R. AINSWORTH DAVIS

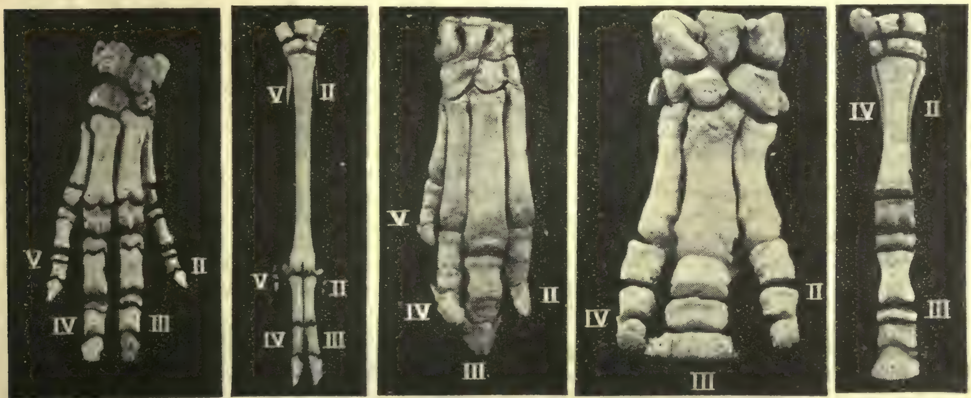
WE have now to consider means of progression. The HOOFED MAMMALS (*Ungulata*) best illustrate structural arrangements which promote great speed, and also the way in which these arrangements have been evolved. As we have seen, the remote ancestors of this group were comparatively small animals, which lived in swamps and damp forests. Their limbs were not particularly long, they were flat-footed (plantigrade), and possessed the full number—*i.e.*, five—of fingers and toes. Such spreading extremities, presenting a large surface, were very well adapted for progression on spongy soil, but not for great speed on a firm surface.

Fleet Mammals. For such rapid progression length of limb is a primary essential, and this has been partly attained in all hoofed forms by abandonment of the old flat-footed attitude for a tiptoe or *digitigrade* one. At the same time there was a gradual elongation of the different sections of the limbs, especially the hands and feet, thus converting them into jointed levers of great efficiency, as may be typically seen in deer and horses. Running, the most rapid kind of progression, differs from walking and the like in that the body actually leaves the ground altogether at regular intervals. This is chiefly the result of sudden straightening of the hind limbs, which by a strong backward push propel the body into the air, to come down again on the fore limbs.

Abolition of the Collar-bone. One result of evolution in the direction indicated has been the abolition of the collar-bones, which would be only a source of weakness in running, as the sudden descent of the body on the fore limbs means a very considerable shock. And the collar-bones are, so to speak, "struts" extending between the breast-bone and shoulder, and ill-suited to resist such sudden impacts.

Spreading extremities, with the full number of digits, suitable for swamp conditions, would "give" too much to render them efficient when employed for rapid movement in a tiptoe attitude on firm surfaces. In the course of evolution this difficulty has been got over by more or less reduction in the number of digits, with increasing size and specialisation in those remaining. To make matters clear, it is necessary to mention here that the digits are numbered 1, 2, 3, 4, and 5, No. 1 being the thumb or great toe, as the case may be. In all hoofed mammals the digits have developed broad hoofs, presenting a firm and sufficiently broad surface for application to the ground. But there have been two lines of evolution, represented by the *even-toed* and *odd-toed* forms respectively, and these require separate consideration.

The Hand of the Pig. In *even-toed* forms digits 3 and 4 have become more or less dominant, and the axis of symmetry runs between them. If we examine the hand of a pig [246] we shall find that the thumb has disappeared altogether, while digits 2 and 5 (the outer ones) are much smaller than 3 and 4, which are the chief agents of progression. But as these creatures have not altogether weaned themselves from the old swamp life, the smaller, outer digits come in handy upon soft ground, preventing their owner from sinking in too far. The palm bones (*metacarpals*) which come between the small, irregular bones of the wrist and the finger



246. Pig 247. Deer 248. Tapir 249. Rhinoceros 250. Horse

SKELETONS SHOWING DEVELOPMENTS OF HANDS

Photographed by Professor B. H. Bentley

bones [246] are moderately elongated. The peccaries of South America are faster runners than ordinary pigs, and we find that their limbs are somewhat longer and more specialised. The hippopotamus, which has to climb the muddy banks of its native rivers, is practically constructed on the pig-type. In this and the subsequent examples the fore limb is taken, but, except where specially mentioned, the hind limb is fashioned in much the same way.

The Hand of the Deer. Turning now to deer, the embodiment of swift progression, we shall find the limbs slender and much elongated, while the hand [247] presents great specialisations as compared with a pig. The outer digits (2 and 5) are reduced to insignificant vestiges, evidently on

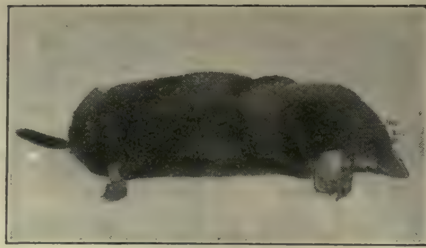
252. ORANG-UTAN *Dando*

the way to complete disappearance. And the palm bones of 3 and 4 are much elongated and fused together into a "cannon bone," which gives greater firmness than if they remained separate. There is not nearly so much specialisation in the pigmy swamp deer (tragulines) native to West Africa and South-East Asia.

Ruminants that Climb. Among ruminants a place of security in which to chew the cud is a matter of considerable importance, and we find that the even-toed foot lends itself to this end by proving an admirable climbing organ. In illustration of this, some antelopes—*e.g.*, the Alpine chamois, wild sheep, and wild goats may be taken.

The camel presents a further point of interest in the modification of its extremities to fit them for progression on hot desert sands. Only the two central digits, 3 and 4, are present and these diverge somewhat, so as to give a firm support to a rounded elastic pad on the underside of the foot.

In *odd-toed* forms the middle digit, 3, is more or less dominant, and the axis of symmetry runs



251. MOLE *Medland*

down its centre. Examination of the hand of a tapir [248], the most primitive existing type of the group, will show that the thumb has entirely disappeared, while the central digit is the largest and most important. The foot is still more modified, for it has lost the little toe, 5, as well.

Spreading Toes. The hand of a rhinoceros [249] shows further reduction, for not only has it lost the thumb, but also the little finger, and the foot is on the same model. Just as the two spreading toes of a wild goat are advantageous for climbing, so are the three spreading toes of the rhinoceros of use for rapid progression on an irregular stony surface.

The Long Hand of the Horse. The horse and its allies constitute the last term in the perfecting of the odd-toed type of foot for rapid progression on a firm surface. In the hand we find the central digit, 3, practically the only one, is of very large size, and its palm bone is much elongated [250]. On either side of this we note, on dissection, however, a narrow "splint bone." The two splint bones are no other than the remains of digits 2 and 4, which have almost disappeared. The elongation of hand and foot is very noteworthy, and the so-called "knee" of a horse is really its wrist, while the "hock" corresponds to the ankle. Our one-toed horses were preceded in time by three-toed ones, and we can trace the descent of these, step by step, from the primeval swamp-dwellers to which reference has so often been made.

Leaping Mammals. Members of several orders of mammals chiefly progress by means

Dando

254. RED-FRONTED LEMUR

of the hind limbs only, which are of quite disproportionate length, and used for the execution of a series of long leaps. The kangaroo is the best known example, and its long thick tail is employed as a balancing organ, useful also as a support in the intervals of rest [240, page 1493]. Some of the African desert types have evolved on somewhat similar lines—*e.g.*, the jerboas, which belong to the order of GNAWERS (*Rodentia*), and the jumping-shrews, which are classed with the INSECT-EATERS (*Insectivora*).

Digging Mammals. Mammals which have taken to pursue underground prey have naturally evolved on lines which have made them efficient diggers. Of this no better example could be taken than that of our native mole [251], a member of the INSECT-EATERS (*Insectivora*). The general shape of the body is adapted to a subterranean life, and the short, strong limbs are scooping organs of great efficiency, provided with powerful digging claws. This applies more particularly to the hands, which serve as spades. There are no external ears, the eyes are very minute, and the short hairs are implanted vertically in the skin, so that there is no particular "set" to the velvety fur, which presents no obstacle to progression either forwards or backwards.

It is of particular interest in this connexion to note that the pouched mole (*Notoryctes*) of the Australian deserts, though belonging to a totally different order (*Marsupialia*), is not unlike a common mole in appearance, being adapted in much the same way to life underground.

There are also diggers among other orders of Mammalia, as rabbits and prairie "dogs" among the GNAWERS (*Rodentia*), and armadillos among the MAMMALS POOR IN TEETH (*Edentata*). In all such cases there are at least powerful digging claws.

253. SKELETON OF GORILLA

Climbing Mammals. Since a tree-life offers abundant food of both vegetable and animal nature, with fewer dangers than life on the ground, it is not surprising to find that it has been adopted by a large number of mammals belonging to different orders. More or less mobility of limb is here an advantage, and this involves, among other things, little, if any, reduction in the number of fingers and toes.

Among the POUCHED MAMMALS (*Marsupialia*) we find the phalangers of Australia and the opossums of America are arboreal, their extremities being adapted for grasping, while in some of the latter there is a prehensile tail, serving as a sort of fifth hand. Of MAMMALS POOR IN TEETH (*Edentata*) the leaf-eating sloths of South America live entirely among the trees, progressing head downwards with complete security, for their long curved claws give a firm hold. In this case, it is true, the digits have been reduced, but a few efficient claws are better than a larger number of smaller size. In the same order some of the smaller South American ant-eaters also affect an arboreal life, as do some species of their Old World relatives, the pangolins, which use the overlapping scales on the under side of the tail as climbing irons.

Caudal Climbing. Among climbing INSECT-EATERS (*Insectivora*) we find the squirrel-like tree-shrews of South-east Asia with their bushy balancing tails, and our common squirrel illustrates the same habit among the GNAWERS (*Rodentia*). In the "flying" squirrels of West Africa there are climbing scales on the under side of the base of the tail. Aided by their sharp claws a number of the FLESH-EATERS (*Carnivora*), from leopards, pumas, and cats, down to civets and some of the weasel tribe, are able to climb with facility. Some of the bears, too, can climb effectively if clumsily.

The MONKEYS (*Primates*), however, constitute the most notable climbing order of mammals [253], both hands and feet being able to grasp branches, as, for instance, in the orang-utan [252]. This is mainly due to the fact that the thumb and great toe can be opposed or placed opposite to the remaining digits. Some of the American monkeys possess a prehensile tail.

Our Tree-dwelling Ancestors. There is no doubt that man himself has descended from arboreal ancestors, and in a young baby the mobility of the toes and the inturned soles of the feet are very noticeable. The power is also possessed of supporting the entire weight of the body by grasping a stick in the hands, though readers will find that there are formidable obstacles in the way of pursuing researches in these matters on very juvenile members of the human species. It has also been plausibly suggested that the fatal instinct of throwing up the arms noticeable in drowning persons may be regarded as an involuntary attempt to grasp the branches of the original tree-home of mankind.

The LEMURS (*Lemuroidea*) [254], sometimes grouped with the monkeys, but in reality decidedly lower in the scale, possess climbing arrangements similar to those just described.

Continued

Group 16 **HOUSEKEEPING** 10 COOKERY continued from page 737	# COOKERY RECIPES **Ingredients for, and Methods of Cooking, Meat Puddings, Pies, and Croquettes. Various Dishes of Fish, Poultry, and Game**

MEATS—continued

Roast Fillet of Veal (Stuffed)

INGREDIENTS. Five pounds of rolled fillet of veal, three tablespoonfuls of white crumbs, three tablespoonfuls of chopped suet, one large tablespoonful of chopped parsley, one teaspoonful of mixed powdered herbs, one egg, half a teaspoonful of grated lemon rind, pepper and salt.

Method. Wipe the joint and remove the centre portion of bone, if not already done by the butcher. Mix together the crumbs, suet, parsley, herbs, and lemon rind. Season the mixture well, and bind it stiffly with the beaten egg ; if necessary, a little milk may be added. Place this stuffing in the space made by the removal of the bone. Tie a piece of greased paper over the meat, see the joint is tied securely in shape with tape or string, and roast it before the fire, or bake it in the oven for about two hours. Remove the paper for the last half-hour. Baste the joint frequently, as it is very lean ; extra dripping must be used for this purpose. Serve with thick brown gravy poured round.

Veal Cake

INGREDIENTS. One pound of lean veal, half a pound of fat bacon, three hard-boiled eggs, two teaspoonfuls of grated lemon rind, two teaspoonfuls of chopped parsley, one teaspoonful of salt, a quarter of a teaspoonful of pepper.

Meth d. Chop the parsley and grate the lemon rind finely, mix them together with the salt and pepper. Boil the eggs for fifteen minutes, then shell them, and leave them in cold water till they are wanted. Cut the veal and ham into neat cubes. Have ready a plain mould, which holds one pint ; rinse it out with cold water. Cut the eggs into slices, and arrange some of them in any pretty device on the bottom and sides of the mould. Now fill in the mould with alternate layers of meat, seasoning, and the remains of the eggs coarsely chopped. Pour in one gill of stock, twist a piece of buttered paper over the top, and cook it in a slow oven for four hours. Then take off the paper, and fill the mould up with stock in which a quarter of an ounce of leaf gelatine has been melted. Leave it till it is cold and quite set. Then dip the entire mould in tepid water, and the cake will easily slip out on to a dish.

Mutton may be treated in the same way, but should be rather strongly seasoned, otherwise it will be tasteless.

Veal and Ham Pie

INGREDIENTS. One and a half pounds of lean veal, half a pound of lean ham (or bacon), three hard-boiled eggs, salt and pepper, some lemon juice, one teaspoonful of chopped parsley, one teaspoonful of chopped sweet herbs, stock to half fill the pie-dish. For the flaky pastry, one pound of flour, three-quarters of a pound of butter, lard, or dripping, cold water.

Method. Divide the butter into four equal parts. Sieve together the flour and the salt. Take one-fourth of the butter and rub it into the flour in the same way as for short crust, and mix it to a paste with cold water. Then roll it out in a long, narrow strip. Spread the second quantity of butter in small lumps over the strip. Shake over a little flour, then fold it evenly in three, pressing the edges together with a rolling-pin ; then roll it out again, and proceed as before. Repeat this process till the four divisions of butter have been used. Then roll out to the required thickness. To make the pie, cut the meat and bacon into neat pieces, and put a layer of the veal in a pie-dish. Shake over it some chopped parsley and herbs, lemon juice, and seasoning. Next put in a layer of ham, then a layer of veal, and so on till the dish is full. The last layer should be ham. Then half fill the dish with the stock—or water, if you have no stock. Wet the edge of the pie-dish and put round it a strip of pastry. Then cover the top of the pie-dish with pastry, of which leaves can be made to ornament it. Brush over the top with beaten egg. Put the pie in a quick oven, and bake it for about two hours.

All meat pies are made in the same way, but omit the lemon when making steak, or steak and kidney pie.

Steak and Kidney Pudding

INGREDIENTS. One and a half pounds of buttock steak, half a pound of beef kidney, pepper and salt, one pound of flour, six ounces of suet, cold water, one teaspoonful of baking-powder.

Method. Cut the steak and kidney into thin slices. Mix together about an ounce of flour and a good dust of salt and pepper ; dip each piece of meat and kidney into this. Chop the suet finely. Sieve together the flour, baking-powder, and a pinch of salt; add to them the chopped suet and, lastly, enough cold water to mix the whole into a soft paste. Roll it out on a floured board, having first put aside a piece to form the lid of the pudding. Grease a pudding basin, and line it with the pastry. Place the beef and kidney in alternate layers in the basin, then fill up with water. Wet the edges of the pastry, put on the lid, pressing the edges together. Scald and flour a pudding-cloth, tie it over the basin, taking care to have a pleat across the top, and tie the opposite corners of the cloth across to keep it in place. Put it in a pan of fast-boiling water, and let it boil steadily for two hours. Then either turn it on to a hot dish or serve it in the basin, with a folded serviette pinned round it. The latter method ensures it being really hot, an important matter in the case of a suet pudding. If preferred, the kidney may be omitted, and half a pound more beef used in its place. All boiled meat or fruit puddings are made in this way.

Croquettes

INGREDIENTS. Half a pound of any cold meat, poultry or game, one ounce of butter or good beef dripping, one ounce of flour, one gill of water or stock or gravy, two teaspoonfuls of chopped parsley, one teaspoonful of chopped shallot, nutmeg, pepper and salt, one egg, breadcrumbs.

Method. Remove all skin and bone from the meat, and chop it finely. Melt the butter or dripping in a saucepan, stir in the flour smoothly, then add the stock, or if poultry or rabbit is being used, use milk. Stir the sauce over the fire till it boils and thickens, then add it to the meat, parsley, onion, salt, pepper, and a dust of nutmeg. Mix all well together, then turn it on to a plate, and spread it evenly over. When cold, mark it into equal divisions. Form them into neat balls. Brush each over with beaten egg, then cover it with crumbs. When all are coated, have ready a pan of deep frying fat; when a faint bluish smoke rises from it put in the balls, two or three at a time, and fry them a pretty golden brown. Drain them well on kitchen paper. Arrange them on a lace paper, and garnish with fried parsley. These croquettes may be made of any kind of meat, poultry, or game, or a mixture of any. If using veal, a little grated lemon-rind is an improvement. They may be reheated either by refrying them for a few seconds, or by putting them in a hot oven.

FISH

Dressed Crab

INGREDIENTS. A good-sized crab, oil and vinegar, salt and pepper, a tablespoonful of white crumbs.

Method. The crab should feel heavy for its size and have large claws. Remove all the meat from the body, carefully picking it out from the claws and the bony part in the middle. Scrape out and save all the soft meat as well. Throw away all bony and finny pieces. You will notice the flesh is of two kinds—a dark, soft kind (which is the liver), and the rest firm and white. Separate the latter into little shreds with a fork or skewer. When the shell is quite empty, wash it well, and rub it with a little warm butter to polish it. Also chip off the under portion so as to leave a neat edge. Mix the soft substance with oil, vinegar, salt and pepper, and, if liked, the breadcrumbs. Toss the shredded meat lightly in the seasoning of salt and pepper and vinegar, but keep the light and dark meat separate. Fill the shell with the two mixtures, arranging them alternately so that they appear in stripes. Pile rather high in the centre, and if there is any coral, pound it with a little butter, and decorate tastefully with it round the shell.

Fish Pudding

INGREDIENTS. One pound of any kind of uncooked fish, three ounces of beef suet, three ounces of white breadcrumbs, one teaspoonful of chopped parsley, one teaspoonful of chopped onion, two teaspoonfuls of salt, a quarter of a teaspoonful of pepper, two eggs, half a pint of milk.

Method. Remove all skin and bone from the fish, then chop the flesh finely; chop the suet also, mixing the crumbs with it while you do so to prevent it from clogging. Put the fish, suet, parsley, onion, salt, and pepper in a basin. Beat up the eggs and the milk, then stir these into the other ingredients, mixing all well together. Thickly grease a pudding-basin, put in the mixture, pressing it down well. Cover the top with a piece of greased paper, and steam the pudding for one hour. Turn it out on to a hot dish, and pour egg sauce all over it.

Tinned salmon is excellent treated in this way.

Fried Fish

INGREDIENTS. One medium-sized sole or plaice one egg, breadcrumbs, a little flour, salt, pepper, and oil.

Method. Wash, dry, and fillet the fish carefully; there will be two fillets from each side. Add to the flour a good dust of salt and pepper; dip each fillet in this, and shake off all loose particles. Beat up the egg on a plate, brush the fish over with it, then cover with breadcrumbs, pressing them firmly on with a knife. Have ready a pan of deep frying fat; when a faint bluish smoke rises from it put in one or two pieces of fish and let them fry till they are a delicate golden brown. Lift them on to a baking-tin lined with kitchen paper, and let them drain well. Arrange them on a lace paper, and garnish them with fried parsley.

Any kind of fish may be treated in this way. Whiting are usually curled round, their tails stuck through the eyeholes, egg-and-breadcrumbed, and fried whole. Cod is generally cut into steaks about an inch thick, then egg-and-crumbed.

Fresh haddock may be filleted, or merely cut in thick steaks.

If preferred, the fish may be coated in batter instead of egg and crumbs.

For the batter, mix together a quarter of a teaspoonful of salt and a quarter of a pound of flour; stir to these smoothly a quarter of a pint of tepid water, and one tablespoonful of oil or melted dripping. Beat the white of an egg very stiffly, then add it lightly to the batter, and it is ready.

Grilled Salmon Steaks

INGREDIENTS. Salmon steaks, medium oatmeal, two ounces of butter, salt and pepper. For the sauce, two teaspoonfuls of horseradish, two ounces of fresh butter, two teaspoonfuls of lemon juice, cayenne.

Method. The steaks should be quite an inch thick. Brush them all over with warmed butter. Roll them in the oatmeal. Heat and well butter a gridiron, lay on the steaks, and grill them over a clear, sharp fire for ten to fifteen minutes; use a fish slice and knife to turn them unless you have one of the double gridirons. When they are a tempting brown, slip them on to a hot dish. Dust with salt and pepper. Put a lump of butter on the top. Serve at once, handing them with Dutch sauce.

To make the sauce, put the butter in a saucepan, and add a little salt. Stir over a slow fire till about three-quarters of it is melted. Draw it to the side of the fire to finish melting. This prevents overheating, which ruins the flavour. Add a dust of cayenne, the lemon juice, and, for this special dish, the grated horseradish. Serve in a hot sauce-boat.

Cod, hake, white salmon, or haddock may all be treated in the same way, while herrings, whiting, and mackerel could be split open and grilled as directed.

Boiled Halibut

INGREDIENTS. About two pounds of halibut, milk and water, lemon and salt.

Method. Rub the halibut all over with salt, then lay it in cold water for an hour. Take it out and rub it well over with a piece of lemon. Put enough milk and water in a fish-kettle to cover the fish; add a little salt—about one level teaspoonful to each quart of water. When the water boils put in the fish. Bring it to the boil, skim well, and boil for three minutes. Then move it to a cooler place, and let it simmer till done. It should take from twenty to thirty minutes, according to the thickness of the fish. When done, the flesh should easily part from the bone. Then lift the fish out of the water, and let it drain. Rub it over with a little butter. Serve on a hot dish on a fancy paper. Garnish with slices of lemon and fresh parsley. Serve shrimp sauce or any nice fish sauce in a hot sauce tureen.

Cod, fresh haddocks, hake, turbot, and brill may be treated in the same way.

Lobster Cutlets

INGREDIENTS. One lobster (fresh or tinned), one ounce of flour, one ounce of butter, one egg, bread-crumbs.

Method. Take out all the flesh from the shell, and chop it finely. Melt the butter in a saucepan, stir in the flour smoothly; then add the water, and stir the mixture in the pan over the fire till it will leave the sides of the pan quite clean. Now add to it the chopped lobster, and if there is any lobster coral add it also, with a good dust of salt and pepper. Mix all well together, then spread the mixture on a plate to cool. Beat up the egg on a plate and make the bread-crumbs ; to do this, rub some stale bread through a wire sieve. When the mixture is cool, mark it out in even sized divisions, and form each division into a pear-shaped cutlet; do this with a knife dipped in flour, and on a slightly floured board. When all the cutlets are shaped, brush them over with the beaten egg and cover them with crumbs. Have ready a deep pan of frying fat; when a faint bluish smoke rises from it put in the cutlets, one or two at a time, and fry them a pretty golden brown. Drain them well on kitchen paper ; into the end of each put a piece of the feeler cut about an inch long. Arrange the cutlets in a circle on a lace paper.

The remains of cold cod, haddock, or whiting are excellent treated in this manner.

POULTRY

Spatchcock

INGREDIENTS. One fowl, salt and pepper, a little chopped onion, parsley and herbs, browned crumbs, an ounce of butter.

Method. Cut the fowl straight down through the backbone, but not through the breast. Dust it well inside and out with the onion, parsley, herbs, pepper, and salt. Skewer the fowl so that it lies quite flat, and brush it all over with some melted butter. Rub the gridiron over with a piece of butter or suet, put on the fowl, and grill it till it is half cooked; then cover it with browned crumbs, and finish cooking it. It will take about twenty minutes altogether. Take out the skewer. Serve the bird very hot, with some good sharp sauce.

Game of all kinds may be cooked in this way.

Boiled Turkey with Celery Sauce

INGREDIENTS. A medium-sized turkey, one pound of pork sausages, salt, pepper, nutmeg, flour, milk, and two heads of celery.

Method. Skin the sausages, then season the meat with salt, pepper and nutmeg. Fill the bird through the neck with this stuffing. Truss it neatly into shape. Put it in a saucepan with nearly boiling stock or water to cover it, bring it to the boil, then skim it well and let it simmer gently about two hours. Meanwhile, wash and prepare two heads of celery, and cut them into thin slices. Melt three ounces of butter in a saucepan, put in the celery, and let it cook slowly for a quarter of an hour—it must not get at all brown. Now stir in the flour, then add one and a half pints of milk. Stir over the fire till the sauce boils and thickens. Season it carefully. Let it simmer gently from ten to fifteen minutes, then rub it through a sieve. When the turkey is done, put it on a hot dish, coat it nicely over with some of the sauce, and serve the rest in a hot tureen.

Chicken and pheasant may be served in this way, but they are not usually stuffed, though sometimes the latter is stuffed with oysters.

Roast Duck

INGREDIENTS. A couple of ducks, two large onions, three ounces of breadcrumbs, six sage leaves, one egg, one ounce of chopped suet, salt and pepper, a little dripping.

Method. First prepare the stuffing. Peel the onions, cut them in quarters, and boil them till tender in salted water. Dip the sage leaves into boiling water for a few seconds, then dry them in the oven till they can be powdered between the thumb and finger. When the onions are tender, drain off the water, and chop them finely; add to them the powdered sage, the breadcrumbs, salt, pepper, and chopped suet. Beat up the egg, and bind the ingredients together with it. The stuffing is now ready.

Pluck and draw the ducks, and wipe them inside with a cloth dipped in hot water. Singe the birds thoroughly. With a spoon put the stuffing into the birds ; draw the flap of skin over the opening, and keep it in place with a skewer or string. Truss the birds into shape. All but the last joint is cut off from the legs and wings ; the wing joint should be firmly stretched out till it almost touches the thigh joint, which must be pushed back a little to meet it. Then either stitch or skewer the limbs in shape. Put them in a baking tin, with the dripping on the breasts, in a quick oven for ten minutes, then move them to a cooler part. They will probably take an hour. Serve them with a tureen of good gravy and one of apple sauce. It is a wise plan to stuff one duck only, as so many people object to sage-and-onion stuffing.

Goose and turkey may be stuffed in the same way, but in the case of the latter the stuffing is put in at the neck end of the bird.

Ducklings, like chickens, are never stuffed, but merely trussed, and put in the baking tin, with a little dripping, and roasted.

Chaudfroid of Chicken

INGREDIENTS. Two fowls, two large onions, one large carrot, two pieces of celery, a bunch of herbs, two quarts of stock or water. For the sauce, three ounces of butter, three ounces of flour, one and a half pints of broth, one ounce of leaf gelatine, a dessertspoonful of cream, salt and pepper.

Method. Truss the fowls for boiling, roll them up in a buttered paper, and tie it up like a parcel. Put them in a pan with the stock and vegetables. Cook slowly till the birds are tender, probably for three-quarters of an hour. Take them out and let them get cold. Melt the butter in a pan, stir in the flour, mixing it in smoothly. Cook these for a few minutes without letting the flour brown. Now stir in one and a half pints of the stock in which the fowls were cooked. Stir over the fire till it boils. Dissolve the gelatine in a little stock, and strain it into the sauce; also add the cream. Place the fowls on a dish, and when the sauce has slightly cooled pour it very smoothly over every part of them. Garnish with two lines of roughly chopped aspic jelly down the breasts of the birds, and make a border round the dish.

GAME

Roast Grouse

INGREDIENTS. A brace of grouse, two slices of bacon, an ounce of butter, two squares of toast.

Method. Pluck and singe the birds, and wipe them inside with a cloth dipped in hot water. Truss them, and tie a slice of fat bacon over the breast of each. Wrap each bird in a piece of greased paper, and put them in a baking-tin, with the butter, in a hot oven. Baste them frequently. After ten minutes take off the paper and bacon, and continue to roast the birds for another ten minutes, but care must be taken not to overcook them. They should be rather under than over done. Put two neat squares of buttered toast under the birds for the last ten minutes of cooking them. Put the toast on a hot dish, and place a bird on each. Serve them accompanied by bread sauce, gravy, and fried crumbs.

All game may be treated in this manner, but woodcock and snipe should not be "drawn."

Salmis of Game

INGREDIENTS. Two or more grouse or partridges, woodcock, or any other game, a quarter of a pound of ham, two shallots or onions, a bunch of parsley and herbs, four cloves, four peppercorns, a bay leaf, a dessertspoonful of rowan jelly, a piece of glaze the size of a pigeon's egg, salt and pepper, one ounce of flour, half a lemon.

Method. Cut the birds, which should be only half roasted, into large joints and the ham into dice. Put these in a stewpan with the shallot, herbs, bay leaf, peppercorns, and cloves, and stir them over the fire till they are a pale brown. Then shake in the flour, and brown that also; now add the stock, and stir it over the fire till it boils. Season it carefully with salt, pepper, and lemon juice and add the glaze and rowan jelly; then simmer the whole very gently for half an hour, adding, if liked, a glass of red wine. Arrange the joints on a hot dish, and strain the sauce over.

Jugged Hare

INGREDIENTS. One hare, one onion, two cloves of garlic, two ounces of good beef dripping, eight cloves, pepper and salt, one blade of mace, two ounces of flour, a bunch of herbs, a small carrot.

Method. Skin and paunch the hare carefully. Cut it up into small joints. Mix together the salt, pepper, and one ounce of flour. Dust each joint over with this mixture. Peel the onion, stick the cloves into it, and tie the herbs together. Put the onion into a brown stew-jar with the herbs, mace, and garlic. Then pour in enough stock or water to cover all. Put on a tight-fitting lid, put the jar in the oven or at the side of the stove, and let its contents simmer gently for two or more hours. Melt the butter in a small pan, stir in about two ounces of flour smoothly, add a little of the liquid from the hare gradually to this flour, then pour the mixture slowly into the stew-jar, and stir it over the fire till it cooks and thickens. Season it nicely to taste with the salt and pepper. Take out the herbs, garlic, and onion. Tie a clean serviette round the jar, and send it to the table. It is a matter of individual taste whether you use the blood of the hare or not; it of course greatly adds to the flavour. It is best to remove the head before serving. Cook the heart and liver separately in a little stock, then rub them through a sieve or chop them finely, and add them to the gravy. Red currant or rowan jelly should be served with this dish.

Continued

FRENCH AND GERMAN

French by Louis A. Barbé, B.A.;
German by P. G. Konody and Dr. Osten

FRENCH

Continued from page 1774

By Louis A. Barbé, B.A.

INDEFINITE ADJECTIVES

The indefinite adjectives are *aucun*, no ; *nul*, no ; *chaque*, each ; *même*, same, self ; *tout*, all ; *quelque*, some ; *plusieurs*, several ; *tel*, such, such a ; *maint*, many a ; *quel*, what.

(*a*) *Aucun* and *nul*, no, are negative, and therefore require *ne* before the verb of which they are either subjects or objects.

They are both singular :

Aucun chemin de fleurs ne conduit à la gloire, no path of flowers leads to glory.

Il n'a aucun emploi, he has no employment.

Nul homme n'est exempt de la mort, no man is exempted from death.

Je n'ai nulle autorité, I have no authority.

(*b*) *Chaque*, each, can only be used in the singular :

Chaque âge a ses plaisirs, each age has its pleasures.

(*c*) *Même* means "same" when it precedes a noun. It means "self" when it follows a pronoun, and is joined to it by a hyphen :

Ils ont les mêmes droits, they have the same rights.

Vous êtes contents de vous-mêmes, you are pleased with yourselves.

(*d*) *Tout*, all, has a feminine form, *toute*, and the plural forms *tous*, for the masculine, and *toutes* for the feminine. It takes the definite article, and is the only adjective that precedes it. A possessive may take the place of the article :

Tout son pouvoir, toute sa capacité, toutes ses forces, tous ses efforts, all his power, all his capacity, all his strength, all his efforts.

In the plural it has the meaning of "every" :

Tous les jours, every day.

When used in the singular, and without the article, it has the same meaning :

Tout citoyen a des devoirs aussi bien que des droits, every citizen has duties as well as rights.

Tout, tous, toutes, may not, like the English *all*, immediately precede a relative pronoun. The singular must be followed by *ce*, and the plural by *ceux* or *celles* : *Tout ce qui reluit n'est pas or*, all that glitters is not gold ; *tous ceux qui le connaissent le respectent*, all who know him respect him. *Tous* may not come immediately after a personal pronoun : We all know him, *nous le connaissons tous*.

(*e*) *Quelque*, and its plural, *quelques*, mean "some," but are more restricted in sense than the partitive :

Nous avons eu quelque difficulté, we have had some (a little) difficulty.

J'ai quelques bons livres, I have some (a few) good books.

(*f*) *Plusieurs*, several, has only one form for both masculine and feminine :

Plusieurs historiens, plusieurs histoires, several historians, several histories.

(*g*) *Tel, telle*, such, are usually preceded by *un*, or *une*, and their plurals, *tels, telles*, by *de*:

Un homme d'un tel orgueil est insupportable, a man of such pride is unbearable.

Il n'y a pas de tels animaux, there are no such animals.

The indefinite article never comes after *tel*, as it does after "such" in English :

Un tel homme est insupportable, such a man is unbearable.

"Such" before an adjective is *si*, used in connection with *un, une*, for the singular, and with *de* for the plural :

Un homme si intelligent, such an intelligent man.

Une si belle maison, such a fine house.

Des hommes si courageux, such brave men.

De si gentils enfants, such nice children.

Tel repeated before two nouns, and used without an article, means "like":

Tel maître, tel valet, like master, like man.

(*h*) *Maint, mainte* is equivalent to the English "many a," but may be used in the plural :

Avec quelques vertus il a maint et maint défaut together with a few virtues he has many and many a defect.

Maintes fois, or *mainte fois*, many a time.

Quel, what, is used in both direct and indirect questions :

Quel livre lisez-vous? What book are you reading ?

Quelle heure est-il? What time (hour) is it ?

Je ne sais pas quelle heure il est, I do not know what time it is.

The names of countries take the definite article except after the preposition *en*, and after the preposition *de* when, with its aid, they form adjectival expressions : *la France, en France*, but *du cuir de Russie*, Russian leather. Before feminine names of countries *in* is rendered by *en* ; before names of towns it is rendered by *à* ; *je demeure à Paris*, I live in Paris ; *Paris est en France*, Paris is in France.

EXERCISE XIV.

VOCABULARY.

âge (m.), age
an (m.), year
argent (m.), silver
armée (f.), army
Ascension (f.), Ascension
Assomption (f.), Assumption
la Bastille, Bastille
la Belgique, Belgium
la capitale, capital
la chute de pluie, rainfall
le centime, centime
le centimètre, centimetre
le chemin de fer, railway

le climat, climate
le commerce, commerce
le degré, degree
le département, department
la distance, distance
la durée, duration
effectif (m.), effective, strength
exportation (f.), exportation
la fête, feast
le franc, franc
la France, France
le globe, globe
habitant (m.), inhabitant
importation (f.), importation
industrie (f.), industry
le jour, day
le jour de l'An, New Year's day
le kilomètre, kilometre
la ligne, line
la Loire, Loire
la longueur, length
la marine, navy
le matelot, sailor
la mémoire, memory
le mille, mile
le navire de guerre, warship
Noël (m.), Christmas
Or (m.), gold
la paix, peace
la partie, part
Pâques (m.), Easter
la Pentecôte, Whitsunday, Pentecost
la période, period
la pièce, piece (of money)
la pluie, rain
la population, population
le port, harbour
le pouvoir, power
le président, president
la prise, taking, capture
la république, republic
la réserve, reserve
la rivière, river
le service, service
le soldat de marine, marine
la Suisse, Switzerland
la superficie, area
la température, temperature
le temps, time
le territoire, territory
la tête, head
la Toussaint, All Saints
la valeur, value
la ville, town

actif, active
anglais, English
annuel, annual
carré, square
commercial, commercial
considérable, considerable
exécutif, executive
extérieur, exterior, foreign
français, French
important, important
juif, Jewish, Jew
long, long
militaire, military
mobile, movable
moyen, mean, average
national, national
obligatoire, obligatory, compulsory
protestant, protestant
tempéré, temperate
territorial, territorial
total, total

célébrer, to celebrate
former, to form
indiquer, to indicate
monter, to man
placer, to place
tomber, to fall
mesurer, to measure, reckon

comprend, comprises
vaut, is worth
élu, elected

à peu près, about, nearly
après, after
dès, from, beginning with
entre, between
en, in
par, by
Paris, Paris
environ, about, nearly
tard, late
c'est-à-dire, that is to say
pour, for
ensemble, together
Lyon, Lyons
Marseille, Marseilles

TRANSLATE INTO FRENCH.

The territory of the French Republic is about 536,500 square kilometres. Its area is nearly thirteen times the area of Switzerland, and more than thirteen times the area of Belgium. Its population is 38,600,000 inhabitants. Each square kilometre has about 72 inhabitants. There are in France 60,000 Jews and 650,000 Protestants. It has 86 departments. Its climate is temperate; its mean yearly temperature is 60 degrees. Its rainfall is 80 centimetres. France forms a republic. At the head of the executive power is placed the President of the Republic. He is elected for a period of seven years. Military service is compulsory in France from the age of 20. The duration of the service is 25 years: three years in the active army, 10 years in the reserve of the active army, six years in the territorial army, and six years in the reserve of the territorial army. In time of peace the effective strength is about 560,000 men. The French navy comprises 450 ships of war. They are manned by about 100,000 sailors and marines. There are five great military ports. Paris, the capital of France, has a population of about 2 millions and a half. Lyons and Marseilles are also two of the largest towns in France. In Marseilles there are 404,000 inhabitants; in Lyons there are 420,000. Paris has more than 900,000 inhabitants more than those two towns together. By its industries and its commerce Paris is one of the first towns in the world. Marseilles is the first harbour in all the Mediterranean, and one of the 10 or 12 most important commercial places of the globe. The commerce of France is very considerable. The average value of its foreign trade is 7,500,000,000 or 7½ "milliards": 4 of importation and 3½ of exportation. The longest river in France is the Loire. The length of the Loire is 1,020 kilometres. The railway lines of France have a total length of 40,000 kilometres. The English measure distances by miles; the French by kilometres. The English mile is 1,609 metres. The French indicate value by francs and centimes. The franc is worth a little less than 10 English "pence." The centime is the 100th part of the franc. There are pieces of silver of 50 centimes and gold pieces of 10 francs. The largest silver piece is the 5-franc piece. In France the feast days are: the 1st of January, or New Year's day, Easter, the Ascension, Pentecost, the Assumption, All Saints, and Christmas Day. All Saints is always the 1st of November, and Christmas the 25th of December. Easter falls between the 21st of March and the 26th of April. The Ascension is also a movable feast. It falls 40 days after Easter. Pentecost falls 10 days later—that is to say, 50 days after Easter. The French celebrate their national feast (on) the 14th of July, in memory of the taking of the Bastille in 1789.

KEY TO EXERCISE XIII.

1. Nous avons passé une quinzaine de jours à Londres.

2. J'ai acheté une demi-livre de beurre et une demi-douzaine d'œufs.

3. Dans quatre-vingt-dix-sept il y a neuf dizaines et sept unités.

4. Il y a une centaine de pages dans le cahier.

5. Quelle heure est-il ? Il est quatre heures dix ; dans cinq minutes il sera quatre heures et quart, et dans vingt minutes il sera quatre heures et demie.

6. Cette rue a un demi-mille de longueur (long) et cinquante pieds de largeur (large).

7. Notre maison a plus de quarante pieds de hauteur (haut).

8. Cette table a deux mètres de long sur un mètre soixante-quinze centimètres de large.

9. Vous avez trois fautes ; je n'en ai qu'une.

10. Douvres est à environ vingt et un milles de Calais.

11. Le Pas de Calais a plus de vingt milles de large.

12. Vous avez gagné plus de cinquante francs de plus que nous.

Continued

GERMAN

Continued from page 1776

By P. G. Konody and Dr. Osten

XXVII. If the Possessive Pronoun [see XVII.] is not directly connected with its substantive by preceding it, it either takes (*a*) the definite article and follows the *weak* declension of the adjectives [see XXVI., 1], or (*b*) it remains without article and takes the inflections of the *strong* declension [see XXVI., 2].

Examples. Preceding the substantive: mein Hut (*m.*), my hat; meine Weſte, (*f.*), my waistcoat; mein Hemd (*n.*), my shirt. (*a*) The pronoun takes the article and follows the substantive: Der Hut iſt der mein-e, the hat is mine; die Weſte iſt die mein-e; das Hemd iſt das mein-e. [There is also a lengthened form with the inserted suffix ig: der mein-ig-e, die mein-ig-e, das mein-ig-e.] (*b*) Without article: dieſer Hut iſt mein-er, dieſe Weſte iſt mein-e, dieſes Hemd iſt mein-es.

1. This declension of the adjectives (*a*) the weak, and (*b*) the strong, is applied to all disjoined possessive pronouns: mein, dein, ſein, ihr, unſer, euer, ihr—*e.g.*: dieſer Hut iſt der ſein-e, der ſein-ig-e, and dieſer Hut iſt ſein-er; dieſes Buch iſt das unſ(e)r-e, das unſ(e)r-ig-e, and dieſes Buch iſt unſer-es. The *strong* inflection is sometimes dropped after the auxiliary verb ſein: dieſer Hut iſt mein-er, and dieſer Hut iſt mein(er).

2. The possessive pronoun used with the definite article takes a capital when used substantively: Ich habe das Meine (or das Meinige) getan, I have done [the] mine (my duty, all I could do). Jedem das Seine (or Seinige), to everyone [the] his (his due); etc.

XXVIII. The prefix ge (see XIV.) cannot be used for the formation of the past participle of verbs with *unstressed* first syllables, such as the verbs with the unstressed prefixes be, emp, ent, er, ge, ver, and zer. These unstressed particles which, detached from the verb, convey no meaning, cannot therefore be disjoined, and are called inseparable prefixes, to distinguish them from the separable prefixes, to which belong the prepositions and adverbs which have also an independent existence. When joined to the verb these separable prefixes are *stressed*. They can be detached from the verb and displaced in the course of conjugation.

1. Verbs with separable stressed prefixes ab, an, auf, aus, bei, hin, mit, um, etc., form their past participle by insertion of the conjugational prefix ge between the stressed prefix and the stem, and by the addition of et or t to the stem of weak verbs [see XIV.], and en or n to the stem of strong verbs, with unchanged or changed vowels [see XVIII.]—*e. g.*: the *weak* verb ſtell-en (to put, to place), joined to the separable *stressed* prefix aus (out) aus'-ſtell-en (to exhibit, expose), forms the past participle: aus'-ge-ſtell-t. The verb entſtel'len (to disfigure, to deform) with the *unstressed* prefix ent, forms the past participle: entſtellt' without the prefix ge. The *strong* verb ſchreib-en, to write (imperfect: ſchrieb, with change of vowel; past participle: ge-ſchrieb-en [see XVIII.]), when joined to the *stressed* separable prefix ab (off, from) = ab'-ſchreib-en (to copy), forms the past participle: ab-ge-ſchrieb-en. On the other hand, beſchrei'ben, to describe, with the *unstressed* inseparable prefix be, forms the past participle: be-ſchrie'b-en. The past participle always forms *one* word: aus'geſtellt, entſtellt', geſchrie'ben, ab'geſchrieben, beſchrie'ben.

2. In the *present*, *imperfect*, and *imperative* the stressed separable prefixes are completely detached from, and placed behind, their verbs: ab'ſchreiben, present indicative: ich ſchreib-e ab, etc.; present conjunctive: ich ſchrieb-e ab, etc.; imperfect indicative: ich ſchrieb ab, etc.; imperfect conjunctive: ich ſchrieb-e ab; imperative, singular 2: ſchreib-e ab! ſchreib-en Sie ab! plural 2: ſchreib-et ab! In the present and imperfect the prefix is placed at the end of the clause or sentence; present: Ich ſchreib-e den Brief ab, I copy the letter; imperfect: ich ſchrieb den Brief ab, I copied the letter; but perfect: ich habe den Brief ab'-ge-ſchrieb-en; pluperfect: ich hatte den Brief ab'-ge-ſchrieb-en; first future: ich werde den Brief ab'ſchreiben, I shall copy the letter; second future: ich werde den Brief ab'geſchrieben haben, I shall have copied the letter.

3. In principal clauses like the above the *constant forms* (past participle and infinitive of the verbs [see XXIV.]) are placed at the end and are separated from the *finite forms* by the objects of the actions, etc. Where both constant forms are used, the infinitive is placed at the end. Examples: Der Lehrer lobte den Schüler, the teacher praised the pupil; der Lehrer hat [finite verb] den Schüler gelobt [past participle], the teacher has praised the pupil; and der Lehrer wird [finite verb] den Schüler gelobt [past participle] haben [infinitive], the teacher will have praised the pupil. Note the difference in the position of the words in the two languages. Literally translated, the German sentence would run: the teacher will the pupil praised have.

XXIX. The Strong Declension of Substantives. Refer to Table VI., page 748.

1. The unaltered plural (first case) [see Table VI., 2, 5] is only formed by *masculine* and *neuter* substantives.

2. The plural with modification of the vowel and no other change [see Table VI., 8] is formed

chiefly by *masculines*, by the feminines die Mutter and die Tochter, and the neuter das Kloſter, the cloister, convent (plural: die Mütter, die Töchter, die Klöſter). The plural of the neuter das Waſſer, the water, is die Wäſſer or die Waſſer, the latter being preferable.

3. The e in the plural, without modification of the vowel [see Table VI., 6] is chiefly taken (*a*) by *masculines* and *neuters*, and only by such *feminines* as end in ſal and nis, and substantives of foreign origin ending in an unstressed as, is, nis, os, us. The latter and all substantives ending in nis double the final s. Examples: die Trübſal (the affliction), die Trübſal-e; die Wild'nis (the wilderness), die Wildniſſ-e; die A'nanas (the pineapple), die A'nanaſſ-e; der Fir'nis (the varnish), die Firniſſ-e; der Iltis (the polecat), die Iltiſſ-e; das Rhino'zeros (the rhinoceros), die Rhino'zeroſſ-e; der Re'bus (picture-puzzle), die Re'buſſ-e,

(*b*) Substantives with a final (round) s change it in the plural (with suffix e) into the long *soft* form (ſ), pronounced as in Roſe. Examples: der Greis (the old man, greybeard). die Greiſ-e; das Los (the lot, lottery-ticket), die Loſ-e.

(*c*) Substantives ending in ß preceded by a long vowel retain both in the plural: das Maß (the measure), die Maß-e; der Schweiß (the sweat), die Schweiß-e. In those with short vowels the ß changes in the plural into ſſ: das Roß (the horse), die Roſſe, etc.; the same change occurs with nouns of foreign derivation ending in an *unstressed* syllable with a final ß: der Kom'paß (the compass), die Kom'paſſ-e; der Kü'raß (the cuirass), die Kü'raſſ-e, etc.

4. The plural with the suffix e and modification of the vowel [see table VI., 7] is formed mainly by *masculines*, and by most of the feminines belonging to the strong declension [chiefly monosyllabics]. The only neuters that take this plural are das Chor (the choir), die Chör-e, and das Floß (the float), die Flöß-e; but it must be remembered that the masculine gender is optional for these two nouns.

5. The plural er [see table VI., 4] is formed chiefly by *neuters*, and by a few *masculines*, never by feminines. The modifiable vowels are modified. Examples: der Geiſt (the spirit), die Geiſt-er; das Neſt (the nest), die Neſt-er; das Gemüt' (the soul), die Gemüt-er; das Ei (the egg), die Ei-er; das Bild (the picture), die Bild-er; der Wald (the forest). die Wäld-er; der Rand (the border), die Ränd-er; das Loch (the hole), die Löch-er; das Buch (the book), die Büch-er; das Haupt (the head, chief), die Häupt-er; etc.

6. The plural with s [see table VI., 9] is formed by substantives of foreign origin (French, English, etc). Examples: der Chef (the chief), die-Chef-s; der Salon (the drawing-room), die Salon-s; der Jockey, die Jockey-s; der Papa, die Papa-s; etc. A few German words take the same plural in vernacular: der Junge (the boy, youth), die Jungen-s [correct form: die Jungen]; der Kerl (the fellow), die Kerl-s [correct: die Kerle]; das Mädel (the lass), die Mädel-s [correct: die Mädel]; das Fräulein (the young lady), die Fräulein-s [correct: die Fräulein].

XXX. The rules of paragraph XXIX., 3 *b*, *c*, are also applicable to the declension of the singular (strong genitive with es or s, etc.).

EXAMPLES:

1. der Greis, 2. des Greiſ-es, 3. dem Greiſ-e, etc.
1. das Los, 2. des Loſ-es, 3. dem Loſ-e, etc.
1. das Maß, 2. des Maß-es, 3. dem Maß-e, etc.
1. das Roß, 2. des Roſſ-es, 3. dem Roſſ-e, etc.
1. das Geheim'nis (the secret), 2. des Geheim'niſſ-es, 3. dem Geheim'niſſ-e, etc.
1. der Il'tis, 2. des Iltiſſ-es, etc.
1. der Kompaß, 2. des Kompaſſ-es, etc.
1. der Küraß, 2. des Küraſſ-es, etc.

EXAMINATION PAPER VIII.

1. Which declension is followed by the possessive pronoun not directly preceding the qualified substantive?
2. What classes of prefixes are known in German verbs, and how do they differ as regards stress and meaning?
3. To which class of nouns do some of the separable prefixes belong?
4. How do verbs with stressed prefixes form the past participle?
5. In which tenses are the stressed prefixes detached from their stems, and where are they placed?
6. What is the arrangement of the constituent of a compound tense (finite verb, past participle, and infinitive) in a German sentence?
7. Of which gender are the strong substantives which undergo no alteration in the nominative plural, and how can the plural be distinguished from the singular?
8. To which gender belong most of the substantives which modify their stem-vowel in the plural without taking a suffix?
9. Which feminine nouns take in the plural the suffix e with, and which without, modification of the stem-vowel?
10. Of which gender are the nouns that form the plural by the suffix er without, and with, modification of the stem-vowel?
11. How is the plural sounded in nouns with a final (round) s in the singular [das Los], and what alteration does the final ß undergo in the plural, when preceded by a long or by a short vowel?
12. Which nouns take the suffix s in the plural?

EXERCISE 1. Insert the missing declensive inflections:

(*a*) Der Griff meines Stockes (*m.*) iſt ſchön;
The handle of my stick is beautiful;
ich gab mein . . . Freunde (*m.*) dein . . Stock (*m.*);
I gave to my friend thy stick,
ſie brach ihr . . Uhr (*f.*); der Deckel (*m.*) ihr . . . Uhr (*f.*)
she broke her watch; the cover of her watch
iſt zerbrochen; er fuhr mit (3) ſein . . . und mit (3) ihr . . .
is broken; he drove with his and with her
Pferden (*n.*); ich ging zu (3) Ihr . . . Ärzte (*m.*); ſie
horses; I went to your physician; they
gingen mit (3) ihr . . Eltern in (4) unſer . . . Garten (*m.*)
went with their parents into our garden
und bewunderten die Schönheit (*f.*) unſer . . Blumen (*f.*).
and admired the beauty ef our flowers.
Eu(e)r . . . Freunde (*m.*) und die Brüder (*m.*) eu(e)r . . .
Your (*pl.*) friends and the brothers of your

Freunde (*m.*) waren in (3) eu(e)r... Garten (*m.*) und
friends were in your garden and
pflückten eu(e)r.. Blumen (*f.*)
gathered your flowers,

(*b*) Ihr Freund (*m.*) ist auch der mein.. (*or* unser..);
Your (*sing.*) friend is also mine (*or* ours);
er brach nicht blos sein.. Uhr (*f.*), sondern auch
he broke not only his watch but also
die dein.., die ihr.., die uns(e)r.., die eu(e)r.., die ihr..
thine, hers, ours, yours, theirs,
und die Ihr..; die Schnelligkeit dein... Hengstes
and yours; the speed of thy stallion
ist größer als die des mein.., des sein.., des ihr..,
is greater than that of mine, of his, of hers,
des uns(e)r.., des eu(e)r.., des ihr.. des Ihr...;
of ours, of yours, of theirs, of yours;
seine Dogge (*f.*) lief hinter (3) der mein.., der dein..,
his bulldog ran behind mine, thine,
der ihr.., der uns(e)r.., der eu(e)r.., der ihr.., der Ihr..;
hers, ours, yours, theirs, yours;
mein Pferd schlägt das dein.., das sein.., das ihr..,
my horse beats thine, his, hers,
das eu(e)r.., das ihr.., das Ihr..; deine Freundinnen (*f.*)
yours, theirs, yours; your friends (*f.*)
sind auch die uns(e)r.., die ihr... Die Wolle mein..
are also ours, theirs. The wool of my
Schirmes (*m.*) ist besser als die Seide des dein..,
umbrella is better than the silk of thine,
des sein.., des ihr.., des uns(e)r.., des eu(e)r..,
of his, of hers, of ours, of yours,
des ihr.., des Ihr..; ich glaube dein... Freunde (*m.*)
of theirs, of yours; I believe (to) thy friend (3)
mehr als dem mein.., dem sein.., dem ihr..,
more than mine, his, hers,
dem uns(e)r.., dem eu(e)r.., dem ihr.., dem Ihr..;
ours, yours, theirs, yours;
er liebt sein.. Freund (*m.*) mehr als den mein..,
he loves his friend more than mine,
den dein.., den ihr.., den uns(e)r.., den eu(e)r..,
thine, hers, ours, yours,
den ihr.., den Ihr.. etc.
theirs, yours, etc.

(*c*) der Stock (*m.*), die Dogge (*f.*), das Pferd (*n.*) ist
the stick, the bulldog, the horse is
mein.., dein.., sein.., ihr.., uns(e)r.., eu(e)r..,
mine, thine, his, hers, ours, yours,
ihr.., Ihr..
theirs, yours.

(*d*) Replace the possessive pronouns in (*b*) by their lengthened form, whenever this form is applicable.

EXERCISE 2. (*a*) Form the present indicative in all persons and both numbers of the following verbs with *stressed separable* prefixes: aufstehen, to rise; anbieten, to offer; ausgeben, to spend; beischließen, to enclose; einschlafen, to fall asleep; hinkommen, to get there; mitnehmen, to take along with; umfallen, to fall [down].

(*b*) Form the *present* tense of the following *strong* verbs with *unstressed* inseparable and *stressed* separable prefixes, the stress marked by an apostrophe *behind* the stressed syllable: ver-ste'hen, to understand; bei-'stehen, to assist; ver-bie'ten, to forbid; auf-'bieten, to call up, to summon; aus-'schließen, to exclude; be-schlie'ßen, to resolve, (finish); ge-fal'len, to please; auf-'fallen, to fall upon (also in the sense of: "to be conspicuous").

(*c*) Form the *imperative* singular and plural in the ordinary and civil form of address of the verbs enumerated in (*a*) and (*b*).

EXERCISE 3. Change the *present* tense of the following *weak* verbs [see XXIV. and Exercise 5*a*] for the *perfect* and *pluperfect* in the arrangement explained in XXVIII., 3; [the verbs conjugated with the auxiliary verb of tense s e i n (to be) are made prominent in print, all others are conjugated with h a b e n (to have)]:

Der Schüler lernt; der Lehrer öffnet das Fenster;
The pupil learns; the teacher opens the window;
der Künstler zeichnet ein Bild; das Mädchen lächelt;
the artist draws a picture; the girl smiles;
der Gärtner arbeitet im (3) Garten; das Schiff s e g e l t;
the gardener works in the garden; the ship sails;
die Kinder spielen; die Mädchen e r r ö t e n; ich liebe
the children play; the girls blush; I love
meine Eltern; er redet Unsinn; du rauchst eine
my parents; he talks nonsense; thou smokest a
Cigarre; ihr badet im (3) Flusse; sie läuten die Glocke;
cigar; you bathe in the river; they ring the bell;
die Kinder zerstören ihr Spielzeug; er lauscht an (3) der
the children destroy their toys; he listens at the
Türe; du begrüßest den Vater.
door; you greet the father.

EXERCISE 4. Form the *plural* (*a*) [without Inflection] of the following substantives, of which those with *modifiable* vowels in the stressed syllable are modified: der Va'ter (*m.*), the father; der Löf'fel (*m.*), the spoon; der Ap'fel (*m.*), the apple; das Fen'ster (*n.*), the window; der E'sel, the donkey; der Bru'der, the brother; der On'kel, the uncle; der Vo'gel, the bird; der Rei'ter, the horseman; der Fa'den, the thread; das Veil'chen, the violet; der Käse, the cheese; der Sattel, the saddle; (*b*) of the following substantives (following XXIX., 3): der Berg, the mountain; der Hund, the dog; das Jahr, the year; die Kennt'nis, the knowledge; der Hirsch, the stag; die Bewandt'nis, the condition, state; das Pferd, the horse; das Haar, the hair; der Kür'bis, the pumpkin; das Lab'sal, the refreshment; der A'bend, the evening; der Preis, the prize; das Moos, the moss; das Fließ, the fleece; der Schuh, the shoe; der Sproß, the offspring; das Geheim'nis, the secret; (*c*) of the substantives following the rules of XXIX., 4: der Arzt, the physician; die Gans, the goose; der Kopf, the head; die Braut, the bride; die Hand, the hand; der Zahn, the tooth; der Topf, the pot; die Faust, the fist; der Fuchs, the fox; die Brust, the breast; der Strom, the stream; die Wurst, the sausage; der Krug, the jug; (*d*) of the substantives following XXIX., 5: das Tuch, the cloth; das Land, the country; das Kind, the child; das Gewand, the garment; das Weib, the woman; das Kraut, the cabbage; das Lied, the song; das Faß, the barrel; das Dorf, the village; das Glied, the limb; der Wurm, the worm; das Gespenst', the ghost (spectre); das Volk, the people. (*e*) Decline the substantives das Roß, the horse (steed); das Los, the lot; das Hindernis, the hindrance (impediment, obstacle).

Continued

NOTE. Courses of lessons in Italian and Spanish begin in the next part of the SELF-EDUCATOR.

EYES AND NO EYES

The Faculty of Observation. How to Acquire it. Training Children to See. The Value of Observation in Practical Life. The Mystery of Vision. What to Observe

Continued from page 1746

By HAROLD BEGBIE

GEORGE MEREDITH has described observation as, perhaps, the most lasting of human pleasures. The man who enjoys the art of seeing beyond all question employs life in a far fuller degree than the man who notes but little as he journeys through the world. But the art of seeing endows its possessor with something more than pleasure; it enables him to attain success in his undertakings with greater ease than is possible for the unseeing man, and it also leads to a more permanent and a far pleasanter development of character.

A Faculty which can be Cultivated. It may be said, indeed, that success in any walk of life depends in no small measure on the degree of observational powers enjoyed by the prize seekers. Thousands of astronomers had looked at the planet Uranus before William Herschel looked and observed that it was not a star. It was another genius of science—John Kepler—who remarked that "God has waited six thousand years for an observer." The man whose trained and patient eyes see everything conquers all things. There is no doubt that many men are born into the world with this gift of observation, but it is a mistake to suppose that the faculty cannot be cultivated and developed by those whose eyes have been altogether untouched by the good fairies. It is a thing to be learned—essentially a thing to be taught to children—and it is furthermore one of the very first and one of the most important mental exercises for developing the creative and inventive faculties of the brain.

Comparison. If you doubt the value of observation, enter into conversation with two travellers, one of whom has the gift and one who has not. The one has nothing to tell you of his travels beyond the baldest and most uninteresting commonplaces of the road; while the other, you will find, can scarcely find words enough to express the pleasure he has derived from a thousand and one experiences of his journey. The one can tell you that he passed along a road, that there were trees by the side of it, a river under the trees, and a few fields sloping upward from beyond the river. The other will make a romance of the very dust along the highway, will tell you the names and describe the colours of the wild flowers growing in the grass beside the stream, will make so actual a picture of the river's curving way that you will persuade yourself you must have visited the scene.

It may be said that the difference between these two men is rather one of expression than of observation, that the eloquent traveller has learned the use and graces of languages, while the dumb traveller has merely put himself to no pains to learn the art of description. But to this we object that all the eloquence in the world does not teach a man to observe interesting things, whereas the art of observation does in the very nature of things urge the mind to suitable and suggestive language. The eloquent man who has no faculty of observation can make you an interesting essay on a broomstick, but he cannot make vividly interesting a description of a journey, however beautiful and inspiring.

The Practical Value of Observation. And just as the faculty of observation renders the one traveller a far more welcome guest at the fireside than his fellow who sees nothing at all, so the same faculty puts into the possession of the mind a plentiful store of material—useful, and in some cases needful—for success in the stern and practical battle of life. It not only makes a journey interesting to its possessor, and not only makes popular him who has it, it is a weapon of the first order in the great struggle of humanity for fuller life and fuller consciousness. The engineer and the poet must both be close observers to be great in their work.

It is possible to teach children the art of observation even in their games. One of the indoor amusements of childhood which never seems to lose its freshness and attraction is known as "Eyes and No Eyes," and consists of seeking for an object which is hidden—but not out of sight—in a room from which the seekers have been momentarily excluded. On their admittance to the room each child is aware that no amount of cupboard opening, lid removing, or lifting and shifting of bric-à-brac, will suffice to discover the object. Everything depends upon sight, and sight alone. The object has been placed in some position in the room which renders it difficult of discernment, while it remains perfectly visible to those who have thus placed it.

Mental Blindness. Another excellent practice is to make children write a description of their bed-room or their father's study, or, indeed, any room in the house with which they are daily familiar. It will be found in many instances that the child is even unable to name the colour of the wall-paper in his own bed-room, while the pattern of the carpet or the shape of the fireplace will present to his mind the most insoluble of problems. Things which his eyes have seen every day for years have been so little observed that he is utterly unable to afford you even the crudest and barest description of them.

But this which is true of most children is likewise true of most adults. Not born to

realise the endless pleasure of observation, and never having been encouraged or trained to develop the faculty, the average person passes through life seeing everything and observing nothing. Life presents to these unhappy ones a confused kaleidoscope of form and colour, a jumble of shapes and lines, with no clear and distinct picture of its meaning or its mystery, with no definite and vivid impression of its reality. Their commonplace book is as empty when they reach the grave as it was when they first handled it in their cradles.

The Mystery of Vision. To comprehend the law of observation, it is necessary to consider something of the mystery of vision. If you consider within yourself, it will probably seem to you that in writing a letter with your eyes fixed upon the paper you see absolutely nothing else but the writing which you thus so assiduously observe. But if you make the experiment, you will find that even while your eyes are following the flowing strokes of the pen you are conscious of many other things than the mere writing. You will be aware of the ink-pot in front of you, of the ash-tray on your right, of the penholders scattered upon the blotting-paper, of the stick of red sealing-wax in the tray beside the ink-pot, of the pile of books and papers on the left of your manuscript, and of several other details of your immediate environment. It is true that you do not see these things with any distinctness, but it is also true that the rays of light which make these things conscious to you as surely enter your eyes and are photographed upon the retina as perfectly and as certainly as is the writing over which you exercise such close and exclusive pains. The difference is that you see and observe the writing, while you only see the surrounding objects of your work.

You will also find in conversation with a person that while your eyes remain fixed on his, and while you may think you see only his face, yet you do in reality see a very great deal of the scene about you. Without removing your eyes from his, you may yet be conscious of the pattern of the window curtains, of the trees out on the lawn, of the dog lying asleep in the sun on the gravel path, of the pictures over your friend's head, of the colour and pattern of the carpet under his feet, of the chairs and tables and sofas in his neighbourhood, and of the clock on the mantelpiece behind him. But while that clock is absolutely real to you, you will find nevertheless that you are unable to tell the time it records so long as your eyes remain faithfully fixed on the face of your friend. You see the clock, but you do not observe it. The rays of light from the dial and the hands enter your eyes and impress themselves upon the retina, but consciousness is not there to record the impression.

The Really Great Man. It may be, as some suppose, that every ray of light which enters the eye, and every vibration of sound which enters the ear, are as tenaciously and as fully retained in that larger memory of which our normal and limited consciousness knows such a very little, as are the vibrations and waves of which we are intelligently conscious; and that some day—as is said to happen to drowning men—we shall re-live in a blinding flash of that memory every single incident and every passing instant of our lives. But, be this as it may, certain it is that we can make more use of the things we consciously and intelligently observe than of the things which we merely see because they happen to be in the line of vision.

Just as in art Michael Angelo could have made better use of a housemaid's mop than a savage could have made of the finest camel-hair brushes, so may defective sight, with a keen consciousness behind it, see more of the world, and see the world far better, than is possible to the finest-sighted eyes among mankind with a stupid and unintelligent consciousness behind them. But while the eyes cannot be changed it is possible to change and develop the consciousness with every fresh experience of life, and one of the very best means for so training and developing the mind is by the eyes, by the education of this very observational faculty of which we have been speaking. This is why we place it first among those mental exercises which make for the happy use of learning; it is, more than all other exercises, a direct and most certain influence in the enlarging of consciousness and the enriching of personality.

The really great man is he to whom the words of Shakespeare are applicable:

> In his brain
> . . . he hath strange places cramm'd
> with observation.

Genius the Fruit of Observation. Genius, indeed, is very largely the fruit of observation. The beauty of the breathing world, the actions and the thoughts of humanity, the moving of the seasons over the earth, and all the change and interchange of daily life—these are the colours with which the great artist covers the canvas of his consciousness, and the closer and the more affectionate his observation of them the nobler and sublimer is the picture. There is no education so thorough as that which has observation for its schoolmaster. To observe a thing puts one into possession of that thing, and every fact profoundly considered becomes in some sense the actual property of the observer. I can persuade myself that Shakespeare had so observed mankind as to feel that he had almost created humanity, and that Wordsworth had so observed the face of Nature as to feel that he had well-nigh fashioned the earth.

This god-like sensation of the true observer is adumbrated by Emerson and contrasted with the slavelike sensation of the man who sees nothing:

"The making a fact the subject of thought raises it. All that mass of mental and moral phenomena which we do not make objects of voluntary thought come within the power of fortune; they constitute the circumstances of daily life; they are subject to change, to fear, and hope. Every man beholds his human condition with a degree of melancholy. As a ship aground is battered by the waves, so man, imprisoned in mortal life, lies open to the mercy

of coming events. But a truth separated by the intellect is no longer a subject of destiny. We behold it as a god upraised above care and fear. And so any fact in our life, or any record of our fancies or reflections, disentangled from the web of our unconsciousness, becomes an object impersonal and immortal. It is the past restored, but embalmed. A better art than that of Egypt has taken fear and corruption out of it. It is eviscerated of care. It is offered for science. What is addressed to us for contemplation does not threaten us, but makes us intellectual beings."

To observe a thing, then, is to think about it, and it is thought that makes us gods. It is the business of the man striving to get the best out of himself, striving to make the utmost of all that he learns and all that he experiences, to observe things, which means to see things as they really are—in a word, to think about things.

How the Faculty may be Acquired. There are many ways of practising the faculty of observation. It is a good method to spend a few minutes at the end of each day in recounting to yourself, or in recording in your diary, the events of the day, with some account of the things you have actually observed. Practise, especially at first, to be perfect in your details. To say that at twelve o'clock you spoke to a man named Brown is not enough; you should be able to say what clothes he was wearing, what is the colour of his eyes, in what fashion he brushes his hair, and something of any peculiarity in his speech or manners. To say that you saw Brown in the hall of an hotel is, likewise, not enough; you should be able to describe the furniture of the place, the hangings of the walls and windows, and the people you notice there.

If you read any of the great novelists you will discover that they have all been careful observers of such details. Balzac, perhaps more than any other writer of fiction, was the scrupulous observer of every detail of environment; he realised more than any other writer the immense importance of giving actuality to the rooms and raiment of his characters, and the success with which he has attained this endeavour proclaims eloquently the indefatigable observation with which he studied the world about him.

Some Great Observers. To read Balzac is to acquire at least the appetite for observation, if not actually the thing itself. We may learn from such authors something of the method of observation. Dickens was a wonderful observer. Thomas Hardy and George Meredith are both observers of a high order, and Guy de Maupassant observed everything that he saw. Read the works of these men, and see how they took note of salient and eternal things, how the smallest and most trivial of human habits—rescued from the web of our unconsciousness—becomes by their observation and thought about them habits that as eloquently declare character and impress personality as the biggest and most universal of things. Notice how they observed. The small thing, if it be the salient thing in a character, is insisted upon; the big thing, if it have little to do with personality, is disregarded. You will find lesser writers insisting with weariness on some gigantic peculiarity of their character, quite ignorant of the fact that such peculiarity does not in any manner help to impress the personality upon the mind. Pere Grandet's eternal "Tut, tut! We will see about it!" is an exclamation illuminating the innermost recesses of that cunning and miserly mind; and the fact that Falstaff plucked at the sheets as he lay a-dying is a thing that makes us almost believe we shed tears for him with Bardolph.

Importance of Discrimination. It is of central importance in this cultivation of the art of seeing to learn to observe salient things. You can by practice quicken the activity of your consciousness into observing many things which you did not see before; but it is essential to remember that the burden of remembrance must not be overloaded with negligible details. Even if it were possible to remember the smallest details, it were wise not to do so, for observation becomes in this fashion an unintelligent and mechanical recorder. But by learning to observe salient things, essential things, things that give startling reality and eternal actuality to remembrance, you cultivate within yourself at the same time a discrimination and a conscious direction of your intellect, which will prove of infinite value through all the days of your life.

Learn first to see, then to see wisely.

Begin by taking note of your own immediate surroundings: the room, for instance, in which you spend the most familiar hours of your day. Note all there is to be seen there; every detail of furniture and ornament, every arrangement of your possessions. Then close the eyes and build up the picture out of remembrance from the mind's eye. Gradually you will perceive that there are some few things which give the character of the apartment—it may be a vase of flowers, a picture, a certain disorder of a small table, and not at all a big piece of furniture, or curtains, or carpet; seize upon these few things and write them on the tablets of your memory. Make no effort to remember the things which have no effect upon the character of the room, but be very sure you have seen all there is to be seen in the room.

What to Observe. In the same way, when you take a walk, do not busy your thoughts with personal troubles and individual anxieties, but study to see all that is to be seen of the street's life. Notice the horses, the windows, the doors, the roofs, and the chimneys. Notice the people, their faces, their clothes, their walk, their manners. And then, on your return home, reconstruct the scene so as to give it, in remembrance, the very reality with which it appeared in your eyes. You will recollect many things which had no real meaning for the scene; do not trouble to remember them. But you will recall a few things which gave the walk its character and its tone; remember these few things, and think about them till they become almost a part of yourself.

I knew a man who once, as a young medical student, took a walk with Dickens, in order to

reveal to the great novelist a method he had for observing people in the street. The method had to do with the science of the physician, and person after person passed in whom the medical student was able to point out the symptoms of some physical irregularity. But presently one passed of whom the medical student had nothing to say, and Dickens immediately discarded the theory. It was, he said, not universal. And then he pointed out to his companion how every man and woman and child, if you looked close enough, has some peculiarity of countenance or gait which differentiates each one completely from the rest; and it was for this peculiarity, he said, that the eyes of the observer should always accustom himself to look. The other method was interesting and clever, but it was not universal. Observation must be catholic.

Development of the Faculty. One of the pleasures of training the mind to observe lies in the swift development of the faculty. Every day one is flattered by an increase of power. The faculty grows with every exercise, and not only in this way does the mind acquire fresh pleasure, but it will be found that in setting oneself to any fresh task one is able to master it with greater ease. For the mind which has learned to observe becomes quick in all its perceptions. It sees almost by instinct the thing that matters, and does not have to blunder through a tangle till the knot is presently discovered. The mind of the practised observer is a quick and an acute mind. It is free from heaviness, is not slow in its judgments, does not begin a task half-heartedly, is not clumsy. The power which it has acquired by patient and contemplative observation is a directing power, a power of mastery. It is no longer a machine working at random, but an engine directed to a conscious end by a vigorous and intelligent overlord.

And this is really what lies at the back of observation, and is, too, the only intelligent reason for education. We have to make ourselves brighter and intenser beings; we have to possess ourselves of a fuller and a deeper life.

The True End of Education. The quickening of consciousness, the vivifying of the personality—this is the end of education, and this is the first fruits of observation. Without the seeing eye, life is but a shapeless and a colourless thing, a blurred impression of a chaotic picture. But with the seeing eye life becomes every day a page of more and more entrancing interest, a book the hours of the sun do not afford sufficient time for reading. I have never yet met a person who was a keen and earnest observer who was also a pessimist. I have never yet encountered a pessimist who was not also a person of no observation.

And as for success in life, you will surely find that no man has yet climbed by his own ladder into fortune and fame who was not in some measure an observer of humanity. It is said that a certain Midland firm made their fortune by the observation of one of its members that the Germans like to buy screws in certain coloured paper packets. A millionaire grocer has narrated how, as a shopman, he studied to see what poor people bought, and, getting his own business, provided only such things, and in such vast quantities, that his windows were the magic spell of all the working-classes in that neighbourhood. In the same way the amazing advances made by mechanical invention have all flowed from the patient observation of engineers. James Watt, observing the steam and the kettle-lid, was doing the same work as the engineer who now observes an engine day after day, and week after week, till he discovers a fresh improvement.

It often strikes the unthinking as strange that improvement should be so slow in mechanical invention. If an engine at all, why not a proper engine from the first? If a bicycle at all, why not a perfect bicycle at the beginning? But man can neither create nor perfect without having something to observe. It needs for the children of men a copy before they can begin to write. And so it happens that inventions come as a surprise even to mechanicians, because there are so few profound observers among their number.

Science and Observation. Long before Darwin men of science had the theory of evolution, and even while he was perfecting his observations, another man of science—Alfred Russel Wallace—was writing a treatise on similar lines. To the generality of mankind this new era in science came as a staggering revolution; by the whole realm of science—the trained observers of nature—it was more or less expected.

I have been told by manufacturers and merchants that they have old clerks in their businesses who have been with them since boyhood, and who are yet as ignorant of the general working of the undertaking at the end of their lives as they were at the beginning. On the other hand, a boy enters the office in a humble capacity, who, while he is addressing envelopes and licking stamps, so observes the methods and the management of the business that in a few years he is able to start a similar business on his own behalf. It is not enough to be assiduous and thorough in one's particular branch of labour; one must also be a close and earnest observer of the entire machinery of the whole undertaking.

The mind must always be roused out of dozing, must always be kept from nodding over life. It is not living to accept the facts of existence in a semi-conscious manner. It is not reading to receive a story in a half-sleepy frame of mind. The intellect should always be braced to receive every effect of life vividly and clearly. The mirror of consciousness must be kept polished.

The mind can never be overworked in this mission of observation. To observe one thing alone, and for a great stretch of time, is more or less injurious; but to observe all things thoroughly is to strengthen the fibres of the mind, and to endow it with a strong and robust constitution.

Continued

TOW AND JUTE CARDING

Tow Carding. Hempen Slivers. Lapping and Lapping Machines. The Special Requirements of Jute Carding

Group 28
TEXTILES
13

Continued from page 1727

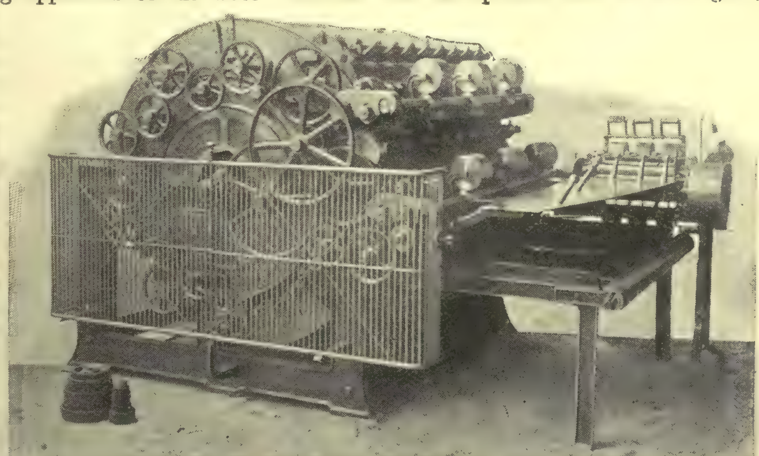
By W. S. MURPHY

IN principle, tow carding is the same as cotton or wool carding ; but it would be altogether misleading to say that the operations are in all respects the same. Every kind of fibre, if it is to be treated to the best advantage, requires its own special carder. The flax manufacturers are right who insist on modifying to their own customs the tools they take from other trades. Tow can be carded on an ordinary cotton-carding engine without the flats ; but the best results are obtained from the engine designed on the lines of the spreader. Here, also, we should perhaps make another preliminary remark. Most persons outside the linen trade have the notion that tow is a kind of waste ; it is nothing of the kind. Its fibres, it is true, have been eliminated from the longer flax, but that may possibly mean a finer quality rather than a lower grade of material.

Special Carder. The tow is gathered into bins and placed near the carding engine [70]. From the bins the workers take the fibre and weigh it. According to the weight of the sliver designed, the weight of tow is spread on the marked area of the feed-sheet. The area is 36 in. and the given weight must be spread evenly on that space. The sheet having been spread, it moves on and up to the feed-roller, which draws in the fibre. The action of this part of the carding engine is the same as in those we have studied, the workers and strippers acting and reacting on the cylinder. Not till we come to the back of the cylinder do we find much difference. Here, instead of the doffing apparatus of the wool and cotton carders, or the delivering rollers of the spreader, we have spiral brush-rollers, which separate the carded tow into three different heads, and deliver them through heavy calender rollers in the shape of flat sliver bands. By the simple device of changing the delivery of the slivers, and sending them all in one direction, they are combined into one thick, filmy rope. On this engine, as on the spread-board, a bell gives warning of the length of sliver paid out into the cans. As may be expected, there is a considerable amount of refuse and rubbish dropped from the tow in the process of carding. This falls into a receptacle placed in the bottom of the carder, and is generally sold to the paper-maker.

Hempen Rope Slivers. We take strong exception to the free-and-easy way of passing over the differences between closely-related fibres which even expert teachers sometimes adopt. It is misleading and unfair. Having been led to think he knows all about one fibre because he has studied another nearly resembling it, the student, on entering into practical work, finds himself confronted by machines and processes which seem to him utterly unlike anything he has been taught to expect. The experienced worker, of course, knows that the difference is not essential ; but it is the superficial difference that strikes a beginner. Hemp and flax offer a case in point at this stage. For the most part, hemp is prepared in the same way, and on the same machines as flax ; but, as we have seen, there are many kinds of hempen fibres, and all do not lend themselves to similar treatment. Moreover, certain advances made in the utilisation of hemp in recent years call for notice.

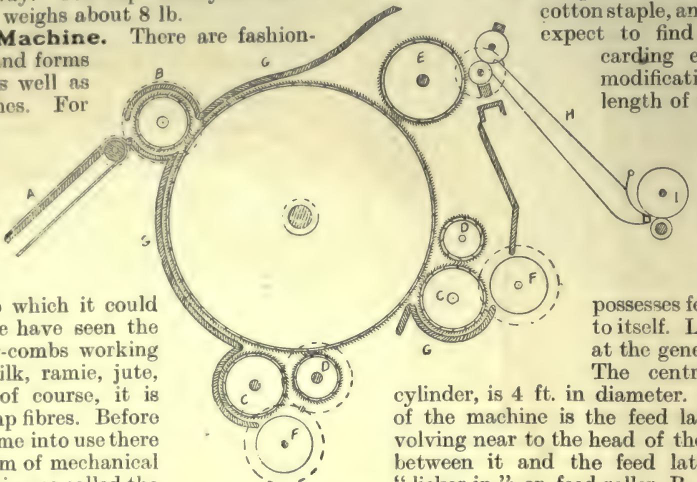
Lapping. When our aim in rope-spinning is quick production, we try to obtain the longest fibre possible at the soonest moment. In many of the leading roperies of this country lapping has been discarded, but in America it has been developed, and a return to it is gradually coming among ourselves. The student is now familiar with the spreader and its screw-gills ;



70. TOW CARDER (Taylor, Wordsworth & Co., Leeds)

but suppose that, instead of the drawing rollers, doubling plate, and sliver rollers, we have a wide cylinder studded with rows of spikes, what would be the effect ? As the faller-combs advance to the end of their career, the long spikes of the revolving cylinder take hold of the fibres and drag them round its huge bulk. When the cylinder has fully clothed itself, the fibres are taken from it, and laid out in what is called a lap. Manilla and sisal hemp fibres are treated in this way. The lap usually measures 19 ft long, and weighs about 8 lb.

A Special Machine. There are fashionable machines and forms of machinery as well as fashionable clothes. For about forty years it was the fashion among textile machinists to use the screw-gill for every conceivable purpose to which it could be applied. We have seen the screw-gill faller-combs working in wool, spun silk, ramie, jute, and flax, and, of course, it is also used on hemp fibres. Before the screw-gill came into use there was another form of mechanical comb used. This was called the sheet gill, an endless band of rods holding upright combs and moving in a horizontal direction.



71. DIAGRAM OF JUTE CARDER

Though out of fashion, the sheet-gill was never wholly forgotten, and it occurred to an ingenious hemp-spinner to try what improving the sheet-gill would do in adding to his machinery. He had, moreover, another end in view. Hemp had not, in his opinion, attained the position in the textile world to which it is entitled. It is well known that the position of jute was very much improved by the oiling of the fibre, and this idea occurred to our friend. A combined hemp spreading and oiling machine was accordingly constructed on the sheet-gill principle. But mark the advance.

In the fore-end of the machine we have the usual feeding apparatus, with the endless band and feed-rollers ; but above the feed-rollers is set the oil-spraying apparatus, Leach's ingenious invention being the one most commonly adopted.

Next is the first sheet-gill, an endless band of bars set with combing teeth. At this point the older form of sheet-gill stopped ; but our new machine goes farther. Another sheet-gill, with finer teeth and running at higher speed, is geared over the bed of the machine. On this second sheet the fibres are drawn out finer and longer. Thence the fine fibres are delivered to the sliver-forming apparatus. One can easily see that a very good and high class fibre can be produced on these machines. Fig. 72 illustrates the hemp-gilling department in a modern factory

Jute Slivers. When the jute fibre comes from the softener, it is about 6 to 8 ft. long. Such a length of fibre cannot be handled by the spinner. Cutting might be resorted to, but that involves a special operation, and adds to the cost of working. The jute spinner has found a simpler way out of the difficulty, and combines the carding of the fibre with the reduction of its length. The first, or breaker card, reduces the length of the jute to about 12 inches. Even this length is great when compared with the 2 in. of the cotton staple, and we therefore expect to find in the jute-carding engine special modifications to suit the length of the fibre.

Jute Carders. The largest machine of the carder class, the jute carding engine, possesses features special to itself. Let us look first at the general structure. The centre, or breast cylinder, is 4 ft. in diameter. At the front of the machine is the feed lattice A. Revolving near to the head of the cylinder and between it and the feed lattice, sits the "licker-in," or feed-roller B, clothed with spiky points. On the lower circumference of the cylinder, we find a pair of tooth-covered rollers ; these are the first worker D, and stripper C. The second worker D and stripper C are placed further round on the cylinder. At the point of inward curve on the back of the large cylinder, sits the doffer cylinder E, and working upon it are two small rollers which operate above the slanting channel H, at the end of which we find the delivery rollers I. Rather strange, and a feature not seen on other carders, are the curving plates G, G, G, which seem to act as guards on the cylinder and stripper rollers. Behind both stripper rollers, also, are tin rollers (F), the functions of which are not familiar to the workers of other carding engines.

Special Characteristics. Studying the jute carder, one almost sees the handiwork of the succession of able and practical men who wrought it into form suited to the special need of the jute industry. In the wool and cotton carders, the teeth of the cylinders point in the direction parallel to the circumference of the cylinder ; but in the cylinder of the jute carder, the teeth point slightly outwards. Perhaps the greatest difference is in the workers and strippers. The workers are smaller than the strippers, their relative sizes being 9 in. and 13 in. in diameter respectively.

Another feature worth noting is the peculiar teeth of the workers. Long, slanted, and turned in the direction opposite to the revolution of the rollers, these teeth have great pulling power. This leads us to note a further singularity in the

machine. With the exception of the feed roller, all the parts of this machine turn in one direction. Workers, strippers, and doffing cylinder run in precisely the same way as the central cylinder. Here is a great result attained by one of the simplest devices known to mechanics—*viz.*, differential speed. The relative speeds are: breast cylinder, 2,000 feet per minute; workers, 50 feet per minute; strippers, 450 feet per minute; doffing cylinder, 140 feet per minute. But the action of the workers and the doffing cylinder is taking off from the central cylinder. In ordinary cases, the carder which takes must run faster than the one taken from. To give so small cylinders such a speed as would enable them to overtake one running at the rate of 2,000 feet per minute was practically impossible. Therefore, the teeth on these rollers were reversed. Rushing past the opposed teeth, the breast cylinder gives them a great pull. Again, though strippers and workers are running in the same direction, the reversal of the teeth of the workers gives the swifter strippers an easy chance of picking off the fibres, while, because the teeth of the strippers are in the same direction as those of the swifter main cylinder, the latter gets back its own.

72. PREPARATION ROOM
First process in preparing hemp for spinning

Saving the Long Fibres. Note that the feed lattice does not come close up to the licker-in. If it did so, the swift spiky roller would break the long fibres with the sharp curves. On the other hand, if left free, the fibres would drop between the licker-in and the feed lattice. To obviate this, the adapters of the jute carder devised a concentric plate to curve below the licker-in, with a broad flange acting as a guard on the main cylinder. This device has worked so happily that the principle has been greatly extended, and the newest carders have guard plates, as shown in our diagram, curving over the head of the main cylinder and round under the strippers. Supplementary to those plates are the tin rollers working behind the strippers. For the same reason, the jute carder has the long conductor channel between the doffers and the sliver delivery rollers. Though the jute has been considerably reduced in length, it is yet a long fibre, and the sliver is correspondingly tender.

Finisher Carding. Jute, except when used for very coarse purposes, is subjected to a second or finisher carding. The finisher card is finer in the teeth, and has from one to three more sets of worker and stripper rollers. The slivers from the breaker card are weighed, and twelve cans are set along the front of the feed cloth, thus forming a lap. By this means the fibres are given an intimate mixing, to eliminate inequalities and combine differences. Here we may also take note of a principle to be exhaustively investigated in our next course, but seen working in the jute-carders to a very pronounced degree. This is the matter of draught. The feed-rollers deliver a sliver weighing about, say, one pound for every half yard in length; but the doffer-rollers run fourteen times quicker than the feed-rollers, and therefore elongate the sliver to fourteen times the length. As the weight does not alter, and the length does, we have a sliver 7 yds. long, weighing only 1 lb. In the finisher card this principle is carried to even greater lengths, the weight of a yard being reduced to about one ounce.

The gigantic fibre has now become a sliver, and is on the way to be made into a thread.

Continued

PHRASING

Scale Playing—continued. Chromatic Scales. Rhythm. Accents. The Pedals. The Importance of Practising the Old Masters

By M. KENNEDY-FRASER

Scales in Double Thirds. Scales in double thirds can be fingered on this same principle of *two* groups to the octave, thus :

3 4 5   2 3 4 5
1 2 3   1 1 2 3

although many finger them in three groups, thus :

3 4 5   3 4   3 4
1 2 3   1 2   1 2

For such three-group system the student may be referred to Leopold Waldstein's "Scales in Double Thirds and Sixths." We had better, perhaps, omit the study of double sixths ; they are dangerous for the hand, unless practised very carefully, and are not very profitable. The two-group system of double thirds as taught and formulated by Mr. Matthay is given below. Note that the groups of four begin with twice thumb or "double-thumb" position, as we shall call it.

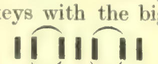
1. All white keys, excepting F and B, like C, counting from key-note :

C
3 4 5   2 3 4 5
1 2 3   1 1 2 3

3 2 1   3 2 1 1
5 4 3   5 4 3 2

Hands *coincide* as to fingering position.

The exception, F, is like C, but begins with "double-thumb" position, instead of the "five-finger" position.

2. B has "all-black" keys position—*viz.*, index finger of both hands in the "double-thumb" position falls on the middle black key of the three, thus: , whilst the combination ($^3_5$, which occurs *twice* in the octave, *always* falls on the two black keys with the big gaps between them, thus: 

Note that the R.H. ($^5_3$ and L.H. ($^3_5$ coincide in the two hands twice in each octave. This fingering applies to the other "all-black" keys—*viz.*, F♯ and C♯, and also to the minors of B and B♭; but in the case of these minors the index finger falls on the *white* key inside the three blacks.

3. In E♭ and B♭ major the "double-thumb" position in both cases begins on the second note of the scale with its accompanying upper third. Hands coincide as in C. These are all the majors, with the exception of A♭, which we shall take with its tonic minor.

4. All minors, with the exception of G♯ minor, C♯ minor, and F♯ minor, are fingered like their tonic majors. The left hand of F minor is also an exception, and is best fingered like C :

3 2 1   3 2 1 1
5 4 3   5 4 3 2

The rule for the set of three minors is double-thumb *on* the notes of the augmented second in both hands—*i.e.*, the repeated thumb occurs in both hands on the sixth and seventh of the scale. A♭ major takes the same fingering as its enharmonic minor—*viz.*, G♯. The ($^5_3$ ($^3_5$ coincides only once in the octave now with the two hands.

Chromatic Scales. Chromatic scales in single notes are fingered normally, thus (beginning on C♯) :

3 1   3 1 2   3 1   3 1   3 1 2
one octave.

or : 3 1   2 1 2   3 1   2 1   2 1 2

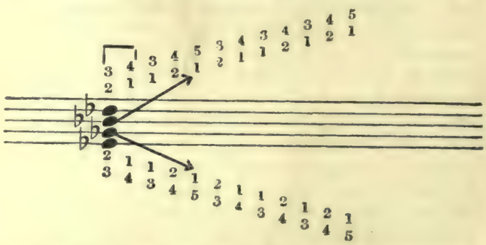
Chopin used also other methods, thus (again beginning on C♯) :

3 4   3 4 5   3 4   3 4   3 4 5

and Busoni, the present-day Italian pianist, thus:

3 4   3 4 5   2 3 4 5   3 4 5

Chromatic scale in double thirds, thus :



Playing them thus by contrary motion on the *keyboard*, the action of the *hands* is exactly the same, the fingering of both coincides. The inside part of both hands has thumb on all the white keys and forefinger on all the black.

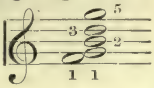
In all double-note scales the legato can only be produced at the finger-group junctions by *one* of the pair of notes ; we must realise this, and rest gently on that particular one, gliding easily to the position of the next pair.

Chords and Arpeggi. The fingering of chords and arpeggi next claims our attention. The normal fingering for the three positions of the common chord in arpeggi is first position (root position), 1 2 3 5 ; second position (first inversion), 1 2 4 5; third position (second inversion), 1 2 4 5—these when the first key of the group is an ivory. The exception comes when in the second and third positions the distances on the keyboard between fourth and fifth fingers is greater than usual, as, for instance, when the interval of the third then lies between B♭ and D or E♭ and G, the middle finger may be used instead of the weaker (fourth) on the black key. But if the hands be large, and the stretch between the fingers ample, it is better to make it a rule to use the *weak* finger here. It makes

for uniformity, and prevents the over use of the strong finger and under use of the weak.

When in an arpeggio the position of the chord offers us a *black* key for the starting point, it is better to postpone the use of the thumb till the first white key is reached in going away from the centre of the keyboard. When we play the arpeggi of F♯ major and E♭ minor, we are obliged to use the thumb on the black keys, as these chords consist of black keys only, the black keys here being treated as if they were all white ones. The normal fingering of chords of the seventh is: 5 4 3 2 1.

Here, again, when these are taken in arpeggio and begin with a black note, postpone the use of thumb in travelling away from the centre till the first white key after a black key is required. It will be found easier always to make the pass under take place between a black key and a white. In fingering chords which include two adjacent keys, both white or both black, the thumb should be used on the two adjacent keys, thus:



Remember, when uncertain as to the fingering of a passage, first to try to find the finger-grouping. We may also try it in the other direction—*i.e.*, if an ascending passage, finger it from the top downwards, and vice versâ, so that we may discover what is the best finger-grouping.

Fingering Sequences. When rapid passages consist of repetitions of the same figure, it is best to finger these all like the first group of the sequence, regardless of the unevenness of the keyboard caused by black and white keys; but this is not obligatory. Fingering chosen must be such as helps to make the phrasing clear, and it depends also on *how* the passage is to be played—whether by finger-movement, hand-movement, or arm-movement, staccato or legato, and so on.

Chopin is fond of playing soft chromatic *marcato* successions of notes from the arm, and for this purpose has a curious but effective fingering—all white notes with the fifth, all the black notes with the fourth finger. See, for instance, the ornamental passages in the well-known E♭ Nocturne. In playing passages thus, turn the hand laterally somewhat, wrist inwards, so that the two fingers (fourth and fifth) could be dragged along over the keys—fourth on the blacks and fifth on the whites. Again, Chopin joins his arpeggi passages occasionally by a smooth lateral movement of the forearm, instead of passing over or under the thumb. All these fingerings seem quite natural when the *muscular conditions* are correct.

Fingering in its details is a variable quantity—what suits one hand and mind may not suit another; but the main rules as to looking for *grouping* always apply. It is well to try the fingering suggested by, say, a Von Bülow in the later Beethoven sonatas, or a Klindworth in Chopin's works, before resorting to one of our own; and also to compare fingerings, and select, if we can find different editions.

Fingered Editions. In choosing fingered editions for study, we should never choose those (like Charles Halle's) that finger *every* note. Nothing is more confusing. The numbers placed above or below the notes should be applied only as guides to the groups of fingering or indications of something unexpected. One should regard them as danger-signals or finger-posts. Thus, one will welcome them as friends and not disregard them as bores. As teaching and self-teaching editions, I would recommend the German "Cotta" editions of the classics—*i.e.*, Clementi, Haydn, Mozart, Beethoven, etc.; Peters' *Kroll* edition of Bach; the Bote and Bock edition of Chopin; and Madame Schumann's edition of Schumann's works. Matthay's "Popular Teaching Pieces," a selection mostly from the earlier composers, as Scarlatti, Paradies, Bach, etc., supply material of the very best for serious students. Here I would urge that all teaching of fingering should now be based on the 1 2 3 4 5 notation and *not* on the × 1 2 3 4, for the very good reason that the cheapest and best and all foreign editions adopt the first mode. Pianoforte music when first published appears, as a rule, unfingered, but fingered editions soon appear if the works are popular; and Germer has done a good deal of the finger editing of such modern composers as Grieg and Tschaikowsky. Siloti, the Russian pianist, has done the same for many of the composers of the Russian school whose music it has been his mission to popularise.

We may have learnt to get out of the instrument all it can give; our tone-production and agility may leave nothing to be desired; yet, unless we learn to phrase well, we shall be incapable of giving musical pleasure to anyone.

Phrasing. By phrasing we mean the conception and execution of notes as intelligent and intelligible utterances. Music is at all times an intelligent and, as a rule, also an emotional utterance, and unless we understand what we have to play, alike intellectually and emotionally, our technique will be a useless accomplishment. For the intellectual grasp of the larger forms, much study and much hearing of music is necessary. For emotional sensitiveness our own temperament must be answerable. To be a good reproducer one must be first a sensitive plate oneself—the music must have affected us strongly before we can affect others by our rendering of it.

Although using the keys with intention and intelligence, we can give expression only to what we ourselves have felt and seen. The reproduction of a work of art is such a delicate operation that *all* our attention is called for, *every* time we attempt it, for every note we play.

Artists say it is practically impossible to reproduce a "Venus de Milo" in marble, and yet this is the sort of thing we pianists attempt every time we try to play a Sonata Appassionata, for example. We may learn much of the generating causes of musical expression by reading such books, which are cheap and accessible, as Bertenshaw's "Musical Form," Riemann's "Musical Æsthetics," Lussy's "Musical Expression," and Carpé's "Rhythm and Phrasing."

Riemann, for instance, shows how music, in the very nature of things, expresses our feelings—that the pulse in music, for instance is analogous to our own pulse—the crescendo and accellerando the natural expression of the human body under the influence of mental excitement, the decrescendo and diminuendo as naturally that of recurring languor. Besides this, music can be "realistic" and imitate things outside of us—things that we see or hear.

The Importance of Rhythm. Much of this tone-painting is achieved by rhythm. We must see to it in our performance that this rhythm shall be *alive*, shall always be freshly *willed*, shall never sink into mere automaticity. We should at all times strongly picture to ourselves the intended rhythms, even in mere scraps of technical exercises, seeing to it that even such a simple scheme as this shall have an intelligible musical shape :

Out of such a fragment Beethoven made his C Minor Symphony. Let us even feel that finger exercises are possible fractions of some great whole.

Where Riemann theorises, Lussy lends immediate practical aid, and is full of examples. He treats of the various kinds of accents—the metrical, grammatical or bar accents ; the rhythmical or phrase accents ; and the rhetorical or pathetic accents.

In his "Introduction to the Elements of Music," Niecks (best known as Chopin's biographer) says : "The phrase accent sometimes modifies and even altogether sets aside and reverses the bar accent." For the phrase groups bars together, and we cannot very well *group* or unite them if we constantly disconnect them by an *equal* emphasis on the strong beat of each. To make musical shapes definite and musical utterances articulate, we may use either a complete disconnection of tones, a momentary silence (often too short to be even indicated by a rest), or a partial disconnection got by accentuation.

We must keep always before us a vivid mental picture of the phrasing, and *listen* to our own performance, that in it we may *realise* this picture. But the thing to be kept chiefly in mind is that every musical phrase *goes* somewhere, that a group of notes means nothing musically until it is, by accentuation, made to point to a climax, a phrase-object, found, as a rule, towards the end of each. "We must learn to perceive," as Matthay says in his "First Principles," "what the music does, where it is that each idea, phrase, sentence, and section has its natural climax or crises." As, for instance, the opening bars of Chopin's E♭ Nocturne :

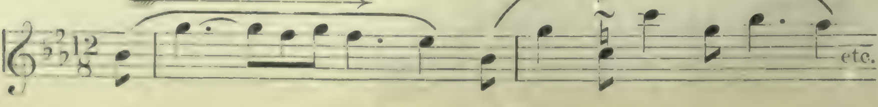
Simple melodic waltzes, with an easy, throbbing accompaniment, make excellent early studies for the purpose of acquiring such rhythmical or phrase sight, and also for the study of tone-quality and tone-quantity as contrasted in melody and accompaniment. Study such waltzes before attempting the art waltzes—the Chopin waltz, for instance—which get many of their effects by deviations from the normal, by the unexpected. We must learn rigidly to obey the law before we can take an artist's licence with regard to it.

Accents. In playing strongly accented notes, let our artistic and our technical judgment both be on the watch, the one seeing to it that the accent is neither stronger nor weaker than is justly due, the other that we guard against (1) using down-arm force, (2) pressing on the keyboard after we hear the sound begin.

Accents and all marcato effects are pitfalls in this respect. We must resist the natural tendency here to use down-arm force, the finger and hand must act *upwards* against the loosely lapsed arm. The unexpected should, as a rule, be well marked ; syncopated notes, therefore (deviations from the natural metrical accent), and chromatic notes (deviations from the diatonic scale), unless the latter be mere unaccented passing notes, call for an accent. Discords are intended to arrest the attention—some musically nonsensitive people play the most poignant discords as though they were as innocuous as the tonic triad. Mentally follow the resolutions of discords in harmonic progressions, and learn, in playing chords, to bring out now one note and now another to this end. To effect this, allow the finger that is to bring out a particular note of the chord to take more weight than the others.

In chord playing from the wrist, the fingers must take up the position relatively to the hand before it descends. To this end we must learn to *mentalise* all the fingers that are to be used in the performance of a chord before we fulfil the act of playing it.

Full chord playing is an important department of modern pianoforte work, and must be specially studied. We must learn to play full chords with loose-arm weight behind the fingers—a consideration which we have already studied—and, when required legato, connect them as closely as possible by beginning the lateral arm-movement while the hand and fingers are still, as it were, lazily lying on their keys, the pedal being used to make the actual tone continuation—this for the interpretation of such passages as the hymn-like chorale middle section of Chopin's Nocturne in G Minor. Here we have an invaluable study in chord phrasing. Connect the chords in groups of eights by the rhythmical balance of the accents and also by the tone.



The Use of the Pedals. This brings us to the use of the pedals. To a passage of this sort we may apply what is called the "syncopated" pedal. The general rule as to pedalling with the damper pedal (the right foot pedal) is that we may depress it, and keep it depressed, as long as the harmony of a passage does not change. When the harmony changes we must lift the foot and release the pedal, instantly re-depressing it if we wish a continuous pedal effect. For detached chords the pedal may be depressed at the same moment as the keys, but in the course of a legato passage the finger and foot must not go down simultaneously. On the contrary, the pedal must rise just as the next keys are being depressed, immediately going down again, however, to continue the new sounds. This "syncopated" pedalling *joins* the sounds without allowing them to overlap. If foot and finger rose *together* there would be a short silence between the sounds.

This syncopated pedalling may be applied to every note of a melody or every chord of a harmonic progression, such as the above-mentioned Chopin chorale. Such constant pedalling in great portions of modern music is absolutely essential, but we must not lose sight of the great importance of *omitting* the pedal at other times. Many players of to-day over-pedal, thus losing the advantage to be gained by the contrast between pedalling and its total cessation. Chopin without the damper pedal would be like a Whistler picture reproduced in the style of Sir Noel Paton. Schumann was a still greater devotee at the shrine of the damper pedal; he did not care about harmonic exclusiveness, he liked to put down the pedal and to keep the course of harmonic changes in unbroken legato—too much so very often, in fact, and the pedalling marks in many of his works require much revision. Chopin was much more refined in his use of the pedal, probably because he was a better pianist. Mendelssohn was ultra-refined, and we must bear this in mind in playing his music; let his outlines be definite, his colours pure, his rhythms free from emotional exuberance; try particularly to be "good," as he himself puts it, and refrain even from a self-indulgent rallentando at the end of a composition.

Use of the "Una Corda" Pedal. The "una corda" pedal should be used sparingly. Modern composers, as a rule, indicate the use of it, as, for instance, Grieg in his well-known Lyric pieces. Very frequently it is used in combination with the damper pedal; the two are quite independent. Use both pedals very sparingly, if at all, in performing the music of Scarlatti, Couperin, or Bach. The first two composed for the harpsichord, and even Bach's clavichord, although it did possess some sensitiveness of touch, was not much like a modern piano.

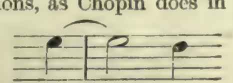
Part Playing. Much modern pianoforte music consists of a melody with accompaniment. We must listen to the *end* of each melody note as much as to its beginning, in order that we may join it perfectly to the following melody note, and that we may choose the right tone for this succeeding note. To bring out the melody also, we must be careful to *subdue very much the accompaniment*, and not let our attention to the *phrasing* of the *melody* be distracted by the accompaniment. If the melody be at the thumb side of the hand, as in Schumann's beautiful Romance in F♯, and in many popular waltzes, remember the use of the rotary relaxation there; if at the little finger side, as more frequently happens, we must see to it that the forearm rotary relaxation helps the weak fingers at that side. Have a melodic ideal ever present—imagine such melodies given out by the 'cello, the violin, or the voice, and imitate these. When a note is sustained while other notes play round it, *listen to the sustained note to the end.*

It is not enough merely to keep the key down; we must connect the sustained tone intelligently with that which follows it in its own part. Practise Bach for such part playing, the playing of several melodies one above the other—his melodies are more difficult to perceive and more difficult to connect subtly than even Chopin's—and listen to all the interwoven parts.

Crescendo and Diminuendo. A perfect crescendo or diminuendo, especially if long sustained, is seldom heard, and yet they are among the most entrancing and convincing of musical effects.

The crescendo in performance was not introduced till late in the eighteenth century, in the orchestra at Mannheim; and when the audience first heard this new effect, it is said they rose from their seats like one man. Realise the emotional possibilities of *nuances* (shading). The secret of getting a good crescendo is, as Von Bülow, the cleverest and wittiest of nineteenth century pianists, puts it, "when you see the expression mark 'cres.' play softly, when you see the mark 'dim.' play loudly." This gives us something to work away from, and prevents our making the common mistake of *at once* playing louder at the beginning of a crescendo, , or softer at the beginning of a diminuendo, .

The same thing holds of accelerations and retardations of time. Accelerando must be gradual and continued, as must ritardando. It is different in the case of ritenuto, which is a *sudden* slackening of the tempo. It requires all our attention to keep an accellerando really accellerating to its climax, and a ritardando really slackening note by note till all animation dies out; "and we must remember," says Mr. Matthay, "that all such effects, both of tune and time, must increase with an increasing *ratio* to be effective." Reference must be made here to time accents, a most effective means of expression. Composers use them in the form of syncopations, as Chopin does in his waltzes:



Time Accents. In performances we can make a melody note *seem* accented by making

it either slightly longer than is due or letting it begin just a very little too late. We may also delay a little the entry of the accompaniment *after* a melody note which we wish to make specially prominent, and then, by hurrying the time a very little, make up for this irregularity. This is the principle of the tempo rubato, which even Mozart employed in a measure, as we learn from his letters, and which must be applied to all modern music since the time of Chopin and Liszt. These two pianist composers were the great protagonists of the tempo rubato, or robbed time.

Although seemingly whimsical and wayward, it is really rooted in a strong sense of rhythmical balance, and Liszt compared it to a tree firmly rooted in the soil, whose branches were yet played upon by the wind. Only those who are anchored to a perfect feeling for rhythmical balance and symmetry can safely trust themselves to the waves of tempo rubato. It takes effect in prolonging some notes, hurrying others, dragging one part of a phrase, accellerating another, either dragging or accellerating a series of phrases and making up for it with the remainder of the period; but, whatever form it takes, it should always be so perfectly balanced that the period ends where the strict metronome beat *would have had it end* had the time never been bent from the straight line. Without the tempo rubato, the music of Chopin would be vulgarised, and much of Schumann rendered unintelligible; but we must beware of applying it to any extent to the earlier composers, as Haydn or Schubert—it would destroy the meaning and symmetry of their music.

Ornamental Notes. It is a mistake to hurry the rendering of ornaments—in cantabile music we should see that we *sing* them. Let them be *grace* notes in very truth, and let them always heighten the particular beauty, and intensify the special character, of the music they adorn.

Quick, light ornaments should be played with as little weight as possible, remembering that such are in truth agility passages of short duration, and that the touch laws for agility must therefore be obeyed in them. Do not (as so many are apt to do) lift away the weight of the hand in preparing for this. Most delicate finger-work, other than pianoforte playing, requires, possibly, that the hand should support itself by its own muscles, and so, instinctively but wrongly, the inexperienced player prepares for a delicate passage by lifting away the weight of the hand. Such a proceeding is fatal to ease, certainty, and beauty of tone. As already pointed out, we must let the hand lie on the fingers, and see that it makes no exertion of any kind in such light passages. "Prepare" such a passage with as many fingers as possible, feel the resistance of keys, let the loose, light weight of the hand *lean* against the keyboard, then imagine the whole group as one concept—not conceiving each note singly—thinking only (if it be a long passage or cadenza) of the notes that form the landmarks of the passages and the fingers that fulfil these "landmark" notes, and leave all the rest to subconscious automaticity.

See that we breathe deeply, fully, freely before starting on one of these long embroideries, such as occur, for instance, in Chopin's Berceuse, and keep the whole body passively quiet meantime, as the least thing will disturb us in the execution of such fairy-like webs of sound. *Holding* the breath through difficulties and subtleties of this kind is a bad habit to fall into. See to it that we use either what Mr. Matthay calls "passing-on touch," or first species, or perhaps second species for the louder portions, and make sure of the preliminary and continuous resting. Let no excitement and nervous tension communicate itself to the up-muscles of the hand, and so cause it to become active to the extent of lifting away its own weight. Then, with a clear mental picture of what we want to produce, "the rest shall be added unto us." To ornaments, as to melodies, the tempo rubato may be applied; shakes may be begun slowly, accelerated towards the middle, and slackened off again towards the end.

Beethoven's Influence on Technique. When sufficiently advanced, we should make not only Bach but Beethoven our daily bread. He will force us to give attention to the music, and to develop a varied tone-palette for its expression. We cannot lazily dream through a Beethoven sonata after having once mastered the art of touch-variety. He expects so much from us, and his expression is often so unexpected, that there is no moment during his music when we may cease to be acutely alert, alike musically and instrumentally. Judging the due amount and quality and time-place of every note from start to finish, and watching key-resistance to see that we realise it, we must get a fine loosely-left arm and well-braced finger and hand for his frequent sforzando staccato chords, and give them with a convincing, well-nourished tone, or sharp finger-action instead, as the case may require. We must learn to obey his characteristic crescendo followed by a sudden piano, and learn to change our technique as suddenly as *he* changes his mood, from the passionately virile to the passionately tender.

From the moment of reading out a Beethoven sonata we should try to "paint" it—that is, try to play it with the constantly changing touch-varieties required. We must not say, "I shall get the notes first and then see what they mean," but look for the meaning through the notes by obeying them in every particular from the first. We should not begin the serious study of Beethoven till we *can* proceed thus. Of course the bravura work—the difficult passages and presto movements—will require to be worked at out of focus, but try even when working at these to conceive their place in the finished scheme. Remember that we never can express all there is in such music unless we obey the laws of tone-production, but remember also that artistic reproduction is the art which conceals Art, which is the goal of all technical study.

Continued

Continued from page 1856

CHINA AND GLASS DEALERS

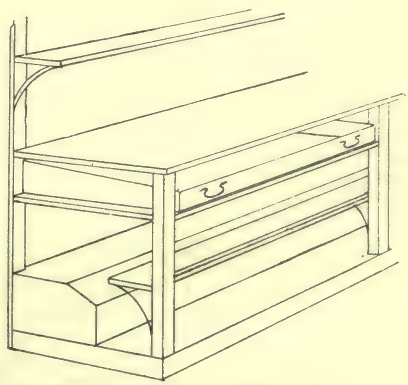
The business of retailing glass, china, and earthenware affords a fair return for the capital invested, whether as a department or as a self-contained business. From £60 to £100 laid out in "pots and pans" would purchase a stock which would make a capital display as a side line in a furniture, drapery or hardware business. Twice the latter sum—more, of course, if possible—would suffice to make a good start on independent lines as a glass and china merchant.

It is erronous to assume that it is a business only suitable for ladies. Properly conducted, it affords sufficient scope for a smart man to make a good living and something more.

The Secrets of Success. A thorough knowledge of the markets, a capacity for salesmanship, and good window accommodation, with adequate show-rooms for displaying the best of the stock, are the qualifications and facilities required to ensure success. A good deal of glass and china can be stored in a comparatively small space, and large stock-rooms are not necessary, but a good light shop, with one or more windows, low down, and deep from back to front is essential. In looking about for a centre in which to open, the retailer must not overlook the outside baskets or boxes. A good deal of trade may be gathered by such fixtures. The public come round to buy a few odd plates or cups and saucers, and these they expect to be able to purchase after examination. They do not care to step in and ask for half a dozen odd cups, but if these be placed outside they pick them out, walk in and pay, stop to look round at better class wares, and usually leave actual or prospective customers. That this is the case has been proved over and over again. We know of one dealer who took premises in a large town for which he paid a rent as high as £300. Without a customer to start with he built up in five years a big cash business, firstly by always having plenty of cheap bargain stock on the pavement outside, secondly by utilising the windows to their utmost, and thirdly by keeping suitable stock inside. His windows were always attractively dressed, no gaps were allowed to be seen, sales from the windows were encouraged, and plenty of inexpensive but attractive stuff was kept well to the front in the shop itself.

Fittings. It is a mistake to suppose that fittings which might serve for such a business as that of a draper or grocer will suffice for the glass and china dealer. Special fixtures are necessary to store the stock conveniently, and to display it attractively.

The details which follow are those observed by a dealer who, as manager and employer, has fitted up a number of shops. Along both sides of the shop, if it be narrow and long, should run a sole not less than 2 ft. 3 in. nor more than 2 ft. 6 in. from the wall, and 4 in. above the floor. On this, next the wall, there should be on one side or both, bins, 18 in. wide by 12 in. deep, to hold the stock most in demand. To hide this stock 8 in. shelves along the front may be fixed for the reception of such wares as teapots and flowerpot vases, for which latter there is always a ready sale. Two feet above the sole is a double bench with an open front into which trays can be slipped. These last are useful for the reception of samples of tea services, trinket sets and the like. The top of the bench is available for dinner services, and above this, right up to the ceiling, should come shelves, 12 in. wide, supported on simple iron brackets secured to battens from sole to ceiling. The



A CONVENIENT CHINA-SHOP FIXTURE

space between the shelves will vary, but at least one should be 17 in. clear above that immediately below, for a smaller space will not accommodate a toilet basin and jug. The general idea is illustrated in the sketch herewith. At the back and round the show-room, if there be one, plenty of 12 in. shelving, with "straight" hooks along the edges for jugs, should be provided, and it may be remarked that it is a false economy to try and make 11 in. boards, cleaned on both edges, answer this purpose. A foot is none too wide. In every case, as well as in the floor stands next described, the sole must be fixed. Its provision obviates much loss from crockery broken by the sweeping broom and the toes of assistants and customers.

Except for a short counter for packing up

parcels, and perhaps a little desk, the floor ought to be reserved for show benches, 36 in. above the floor, and not less than 3 ft. wide. Under and upon these, movable tiers for the reception of stock may be devised. The great thing is to provide plenty of flat spaces upon which stock may be placed ready to the hand of customers. It is safe to state that plain figured stock that can be handled and examined freely will sell itself over and over again.

The colour scheme should be simple and severe—walls distempered, or papered with a self-colour paper—brown paper is excellent—and all the wood painted and varnished without any relief. Black takes a great deal of beating, but a dark sage green or an "invisible" blue may be tried.

Stock Fixtures. Stock fixtures, whether in the basement, warehouses, or stock-rooms, may be open framework, built up of 3 in. by ½ in. deal, arranged with from 2 to 4 in. spaces between the battens. This saves timber, and facilitates the handling of the stock. The fixtures should be divided to about 27 in. every way — that is, equally dimensioned from back to front, top to bottom, and in width. The front of each bin ought to be protected by a batten or two, nailed along the front, if small stock such as tumblers are intended to be stored.

Salesmanship. The second point of importance is a capacity for salesmanship. This cannot be taught by book, but some remarks may help the novice. He must have a thoroughly sound knowledge of the technical details of his business, and these, although not over numerous, are peculiar. Earthenware is bought by count on a plan recognised by no other trade, and this is apt to puzzle a beginner. Take pudding-bowls as an example. A dozen does not mean twelve, but a variety of sizes between nine and forty-two to the "dozen." That is to say, the dealer buys nine, or eighteen or thirty, as the case may be, for the same price as he pays for twelve of a certain size, the nines, of course, being larger and the others smaller, than the normal or basis pattern. Knowledge of all this comes with experience born of actual contact with the goods. It is not of the kind required when dealing with purchasers. These, however, like the salesman to tell them facts about the quality of the ware—how it is decorated, and its probable utility and durability under ordinary conditions of wear; as in many other businesses, a "talking" acquaintance of one's goods greatly facilitates the sales, and the glass and china dealer needs, therefore, to learn all that he can about the novelties that are introduced to his notice from time to time.

Where to Buy. The third essential to success is a knowledge of the markets. At the beginning a novice may place himself in the hands of a reputable house handling the productions of half a dozen manufacturers. There are many such in London, mostly in the vicinity of Holborn Circus. Owing to the conditions under which the pottery trade is run, these firms have ordinarily a pull upon the sources of supply which preclude the small man from getting better terms at first hand. As a retailer's business progresses, however, manufacturers' travellers begin to find out his shop, and invitations will follow to visit their show-rooms, opened in some hotel in the place or in some neighbouring town. These displays of new wares should on no account be overlooked. A visit carries no obligation to purchase, but unless one is made competitors will step in and secure sole selling rights in the best patterns, and the most attractive novelties.

Buying Direct from Works. The next stage in the acquisition of knowledge of the markets is a periodical visit to the Potteries. At first the dealer may have some difficulty in getting what he wants on such occasions, but if he makes it clear to his wholesale people that he is bargain hunting, and that unless he gets bargains there will be no stock orders, these visits will not be in vain. Obviously, the manufacturer of pottery wants to sell his best wares at full prices. He is not proud of his failures, and unless a dealer can convince the maker that he can sell best and "seconds" side by side, he will hear little about and see less of the latter on the occasion of a visit to Staffordshire. As, however, "seconds" are always being made, the manufacturer is usually keen to meet the man who treats with him fairly in the matter of sales of his first-class productions.

Seconds. It is commonly supposed that "seconds" cannot be mixed with the best class of trade. With but few exceptions, however, there is always room in a good general shop for well bought "seconds," but they *must* be well bought, or the dealer is likely to become filled up with unsaleable stock. It should be explained here that the term "seconds" is applied to pottery which is quite sound but not perfect. Cracked and chipped wares would not be included, ordinarily, in the category; but articles with fire marks in them, of slightly irregular shape, or imperfectly decorated, would be entitled to be called "seconds." This quality is usually offered in assorted crates at £5 or £10, the selection being made by the manufacturers. At other times — and this plan is the better of the two — the dealer bids an "over-head" or "overall" price for what is shown him at the works; that is, he takes the parcel at per piece, according to the class of goods offered. Thus, he may buy a thousand cups and saucers at a penny apiece, or a hundred toilet basins and ewers, etc., at a shilling each. When he gets these home, he may find that he has to sell half the cups and saucers at just a trifle over the price he paid for them, but the rest may fetch any price between 3d. and 1s. per pair, and thus a handsome profit on the outlay is reaped.

What to Buy. The stock will, or should, consist of certain well-defined classes of ware. First there will be the common kitchen goods in stoneware, such as glazed brown bowls for bread and cake making, and washing-up dishes, foot-warmers, breadpans, cane and white

bowls, and heavy ware generally. Next there will be white pudding-bowls, basins, pie-dishes, common jugs, "pheasant" or "willow" pattern plates and dishes, brown Rockingham teapots, and the like. Better than these, will be printed (decorated) earthenware jugs, teapots, cheese dishes and covers, and then come sets of toilet ware, dinner services, the latter being obtainable also in a higher grade known as semi-porcelain. This class of wares comes from the district known as the Potteries. The chief towns where this industry is carried on are Stoke-on-Trent, Hanley, Longton, and Burslem.

China. Porcelain, or china, as it is commonly called, comes also from these districts. Tea services and fancy table dishes and appointments naturally come under this head, and in this department the Potteries are unbeaten for style, quality, or price. Curiously enough, trinket sets for the toilet table are made only in limited quantities in Staffordshire. Large quantities are imported from Germany, and these have to be sought for in the London stock-rooms already mentioned, for most of the agents also represent one or more Continental houses, while others are to be found in and about Fore Street, E.C.

Glass. Fancy glass ware, and, indeed, most of the fancy goods retailed in a china and glass warehouse, come from the Potteries. Stourbridge is the centre of the glass-making trade, and much of the best crystal table glass comes from that quarter, as, for example, wine-glasses, tumblers, finger-bowls, table decorative glass, salt cellars, water jugs, carafes, and ups, either plain or cut. Moulded glass also comes from Staffordshire, but Belgium and the Continent compete for this class of trade, and the United States also has made a bid for a share of the business. The firms competing with the British makers are almost all represented in London by sole agents or wholesale houses.

Profits and Expenses. The profits on the sale of china, glass, and earthenware vary largely. Some of the common stock carries barely 20 per cent. profit on the cost prices. Better classes of earthenware, toilet sets, dinner services, and the like, show about 30 per cent. China and fancy glass carry 40 or 50 per cent. margin, and good utility glass in good class districts about the same. Moulded glass varies between 25 and 30 per cent. Seconds well bought often run to from 50 to 70 per cent. profit on the outlay, and many of the fancy ornaments can be bought to show a cent. per cent. profit on cost. On the aggregate an average gross profit of 30 per cent. on the turnover may be expected. Against this, expenses have to be set off. Rent is undoubtedly the heaviest, and ought to be. Success cannot be won in a back street, and the first thing a dealer must face is a stiff rent, with its concomitant of heavy rates and taxes. Other than this, the expenses are comparatively small. The assistants required in the shop will be young women, earning from four to possibly twenty shillings per week. Something must be allowed for breakages, and carriage and packing are important items which will require close watching.

Advertising. The question of advertising is being dealt with at the end of this course. Here it is necessary only to emphasise its importance in the glass and china trade, and, whatever plan is adopted, it should be systematically pursued. How much of the profits should be located to this purpose each man must decide for himself. Probably 5 per cent. of the turnover is not too much to set apart. Without doubt, £50 out of every £1,000 taken could be profitably spent in circularising the town areas and bill-posting the outlying country district, besides which the local press must on no account be neglected. In the last case, however, patterns and prices ought to be given in detail, and different matter ought to appear each week.

A good plan in this connection is to advertise every time one has special bargains to offer, and to make a point of having special lines for the purpose at least two or three times a year. A reputation for real bargains is the best advertisement a dealer can have, and bargains cannot be offered without vigilance and a first-hand touch with the manufacturers or their accredited agents. It always pays to cultivate personal friendship with the manufacturers and their agents and travellers.

CHIROPODISTS

Chiropody is sometimes classed with "pedicure," and pedicure has been described as doing for the foot what manicure does for the hand. But chiropody, in its complete and proper application, embraces more than either. Chiropody should not be confined, nor allowed to degenerate into mere decortication, or corn-cutting. It should be approached through the portals of preliminary study of the anatomy of the foot—its proper functions and their abuse, its proper clothing and the results of improper clothing, its peculiar maladies and the causes of them. There should also be a real mastery of the remedial treatment required. All available technical literature should be carefully studied, particularly those works which treat reliably of excrescences, suppurations, ingrowing nails, etc. A knowledge of chemistry in its relation to asceptics, antiseptics, and curatives, together with local anæsthetics for deadening pain in the more complicated and difficult operations, is also an essential to success.

Scope of Chiropody. The true status of chiropody is that of a specialised form of minor surgery. It is extensively linked on to the ancillary qualifications of the hairdresser's saloon, and no doubt it affords a platform from which the barber, by proper study and skill, may regain something of that nobler position which was once held by the members of that trade, as barber-surgeons, before the surgeons divorced themselves in the time of Henry VIII. In practising chiropody, the barbers are, in fact, merely continuing a form of minor surgery left to them by the surgeons at the time of their separation from their former coadjutors. It may

be true to-day that a patient suffering from foot troubles may obtain superior medical advice from a doctor ; but it is equally true that the patient would get a more dexterous use of the knife for painful corns and callosities from the expert chiropodist. Few people, nowadays, would hie them to a surgeon to extract a painful corn, or foot wart ; and it follows that chiropodists, or hairdresser-chiropodists, have a fair field of this minor surgery open to those of them who approach it from a scientific standpoint.

Instruction. There is no system of apprenticeship, or its equivalent, in the chiropodist's calling. Nor are there any recognised teaching institutes. The usual procedure is for an aspirant to take a course of lessons from a practical and experienced practitioner, whose fee is generally about 10s. 6d. per lesson. Half a dozen such attendances, with interim practice on acquaintances and friends, should qualify a pupil to deal with ordinary corn-cutting. The lessons are at first directed to guiding the student with regard to what he should not attempt ; in other words, to keep him well within a circumscribed area of primary treatment until his own intelligent interest in his work, combined with full practice, and the necessary experience, should make him competent to undertake the cure of the more advanced and complicated disorders of the feet. For a course of six or ten lessons at, say, 10s. 6d. each, there is usually an understanding between pupil and teacher that the former can keep in touch with the latter, in order to ask questions and seek advice in any cases with which he may come into contact, and which present some difficulty or possess some uncommon feature.

Nature of the Work. A qualified chiropodist should be capable of tending all the maladies indigenous to the foot — chilblains, bunions, malformed toes, freakish and ingrowing nails, callosities resultant from walking, or other cause, soft and hard corns, etc. That is the bona-fide standard to which a genuine chiropodist should aspire, and it is perhaps to be regretted that in Great Britain there is no recognised Board of Examiners to sift quacks from qualified operators, and certificate them accordingly. But this may come.

Where Chiropodists Practise. Taking the majority of chiropodists, it may be said that they were barbers first ; and it is generally found that Turkish baths present the best opportunities for acquiring practice and proficiency. In the few cases in which chiropodists are employed exclusively, the pay is £2 per week, and commission, which averages a similar amount. Hairdresser-chiropodists do not actually command any more, but they often get it in the form of commission, which in many instances is arranged on the basis of an allocation of half the fees charged. Some chiropodists only obtain 25 per cent., but a man who "knows the ropes" insists on, and secures, the higher proportion of his earnings.

Charges for the Work. The charge for ordinary corn treatment, to state an average, is 2s. per foot, but this is raised to 2s. 6d. in some instances, and by the best practitioners to 3s. 6d. For difficult cases, demanding more advanced skill and experience, the fee fluctuates between 10s. 6d. and £1 1s., according to the nature and the extent of the treatment involved. An outfit of instruments—supplied by the chiropodist himself — costs from 25s. to £3. Specially adapted chairs and stools are employed by the foremost men, at varying prices.

Legal Status of Chiropodists. In the matter of safeguarding the profession and ensuring that only properly trained and efficient chiropodists are permitted to practise America is well ahead of Great Britain. A society of chiropodists exists, for example, in the State of New York, under the name of the Pedic Society. Organised in June of 1895, members are admitted to this society only by examination, and no one may practise within the confines of New York State until he has shown himself to be fully conversant with the anatomy and physiology of the feet, therapeutics, chemistry, minor surgery, and bandaging. If the student can show an average proficiency of seventy-five per. cent. in these subjects, he is granted the certificate of the Pedic Society, which entitles him to practise the art of chiropody within the State. The examiners adopt a high standard of examination, and to secure the required percentage of points the candidate must be really competent and have studied deeply and thoroughly.

The chiropodists of the State of Illinois are similarly supplied with their representative institutions, and have a Bill before the Legislature at Springfield, seeking powers to enforce examination and registration of all chiropodists practising within the State. The membership fees of this society are as follows : Initiation, one dollar ; assessment, 10 dollars ; monthly dues, 50 cents. The assessment fee was required from all members at the time of the society's formation, to supply the necessary finances, and all new-comers are now required to contribute a similar sum.

CLOTHIERS

To many young men engaged in the clothing trade the all important question is, What capital is necessary in order to start in business and achieve success ? The answer to this query must depend on the inquirer's idea of success. If he be content to make only as much as he would in a situation, then the answer is fairly easy ; but as many young men get the notion that to be in business for themselves warrants their living in a far more extravagant way than formerly, the problem becomes more complex.

Let us assume the case of a man who would consider himself successful if his returns reached from £1,200 to £1,500 per annum. It may be taken for granted that he will not turn over his stock more than two and a half times a year, which means that he will want a stock of about £500, and to hold this and take his discounts he should have a capital of from £200 to £250. Taking it for granted that such is forthcoming, his first step should be to go to some firm of

repute with whom he intends to do a fair share of business and state his case with the view of opening an account with them on the usual trade terms, and asking them to act as his reference house. Needless to say, the best possible firm should be chosen for this purpose, as their standing will influence the opening of other accounts.

Taking a Shop. The acquisition of premises will be the next thing, and in doing this many points should be considered. The position should be as commanding as possible, and in proximity to other shops patronised by the class of customers for whom he intends to cater. The fact that the business of other clothiers is carried on near by is often an advantage, as it creates a market for goods of this class.

It is always advantageous to have a corner shop if possible, and under any circumstances it is essential to have good windows for display. A double-fronted shop is very suitable for clothiers, as one side can be devoted to ready-made clothing and the other to hats and ties, hosiery, etc. The rent should not exceed 3 to 4 per cent. of the anticipated returns—thus, anticipated turnover, £1,500; rent, from £45 to £60 per annum. The shop should, if possible, be taken for a year, with the option of a lease for seven, fourteen, or twenty-one years. Fronts are often put in to suit tenants, especially in new premises; but if a new front has to be put in, and extensive alterations made by the tenant, the rent should be correspondingly lower. The tendency of the times is to go in for very elaborate shop-fronts, name-boards, and fittings, but we would advise caution. It is certainly most desirable to make a good start, but most essential that in doing so the starter should not cripple his finances.

Fittings. The fittings of a clothier's shop need not be very costly. Plain shelving of sufficient width and depth to take the stock will suffice, and the shelves should not be carried too high.

One or two mirrors are essential, and they can often be arranged very effectively at certain angles, so that, while they serve the purpose of letting customers judge the suitability of the articles tried on, they also add to the appearance of the size of the shop. The fittings for a clothing window need not be elaborate. A few shoulder busts, a few planks and boxes on which to stand them, and a supply of neat but effective tickets, will suffice; but for the outfitting window a supply of brass rods and brackets, hat-stands, etc., will be necessary. We have seen many cheaper substitutes used for brass fittings for this purpose, but in the long run the brass ones are the most effective and the most economical. Tickets are, of course, an essential, but their style must be in harmony with the class of trade catered for, and should always be refined rather than gaudy, as the former invariably suggests a better quality of goods than the latter. Many business men have the leading features of their businesses indicated by enamel letters on the upper part of their windows, and this helps to make the premises attractive. The question of light must be to a certain extent decided by local conditions. Electric light is clean and very effective, but it is a mistake to have very powerful arc lamps for illuminating purposes; they are trying to the eyes of customers, and give an unnatural appearance to the goods. Gas has many advantages, especially when the most up-to-date fittings are used. To sum up the question of fittings, let them be selected with taste, and with the view of making the window one of the best possible advertising agencies.

Buying the Stock. Before starting to buy, the beginner should carefully plan his expenditure out. Let us suppose that he feels justified in purchasing a stock to the value of £500. He must decide how much of this will be spent on ready-mades, how much on hats, hosiery, shirts and collars, ties, mufflers, bags, rugs, jewellery, and sundries. Assuming that he intends making the sale of ready-made clothing the mainstay of his business, the larger portion must be devoted to goods of that class.

Some men specialise in certain departments, such, for instance, as juvenile clothing, trousers, or any other line they may fancy; but in any case the speciality chosen should be an article for which there is a good demand, and which can be done really well. Having decided the various proportions of the stock, the details must be decided on—such as sizes, prices, etc.—and in both cases it will be safe to anticipate a larger sale of medium sizes and medium prices. In the men's department, sizes 4 and 5 are the best sellers, as they fit men of 36 to 38 in. chest measurement. The larger and smaller sizes must, of course, be stocked, but only in about half the quantity. Some of the cross sizes are exceedingly useful, and enable the clothier to fit the tall and thin, or the short and stout types, so that a selection should be kept.

Stock must be Representative. Generally speaking, the stock should be of as representative a character as possible; the patterns of the cloth and the styles of the garments such as will find favour with the inhabitants of the neighbourhood. Exceptional requirements can always be met by the aid of a pattern-book supplied by one of the wholesale bespoke houses who cater for the clothiers in this department. In hat stock, the best selling sizes are $6\frac{3}{4}$, $6\frac{7}{8}$, and 7, it being the usual thing to assort them up in half-dozens, as follows:

One $6\frac{3}{4}$, two $6\frac{7}{8}$, two 7, one $7\frac{1}{8}$; or
One $6\frac{5}{8}$, two $6\frac{3}{4}$, two $6\frac{7}{8}$, one 7.

The same rule applies to collars and shirts. The best selling sizes are 15 and $15\frac{1}{2}$ neck; but it is usual to stock from 14 to 17. This must be the plan to work upon, aiming at a representative stock rather than a heavy one, as in these days of quick conveyance goods can easily be replaced as they are sold out week by week.

Terms of Trading. It is usual for wholesale houses to date opening and season parcels forward for from two to four months, after which they give one clear month's credit

(and sometimes two months), and allow $2\frac{1}{2}$ per cent. discount. This means that the tradesman gets from three to six months' credit for his season's parcels; but for his ordinary purchases and sorting-up lines the terms are one clear month only, if discount is to be taken, so that goods purchased during February have to be paid for in the beginning of April, the latest date for taking the discount being the 10th.

Credit. It is, of course, essential that the young tradesman should take advantage of this credit as far as possible, but there is a temptation to overbuy when long dates are offered, and this all too often results in bad stock, so that while it is a great mistake to starve the stock, yet it is far worse to get it choked with unsaleable goods, which not only depreciate in value but lock up the capital in a very unprofitable manner. The young tradesman should carefully watch in these directions, for he can hope to get the best terms only when he keeps his financial engagements with the utmost punctuality. The usual terms for prompt cash are $3\frac{3}{4}$ per cent., though some of the best houses only allow 3 per cent. discount.

Readers may be advised to study the kindred articles in this course, particularly those on DRAPERS, GLOVERS AND HOSIERS, OUTFITTERS AND TAILORS.

Advertising. Assuming that the shop has been taken, and the stock purchased, the opening day comes in due course, and here let us warn against undue haste. Do not try to start before you are ready, for it often makes a bad impression that it is difficult to remove. The advertisements sent out should state clearly the class of business you cater for; they should have the address of the premises prominently brought out, while any special qualifications the tradesman may possess and which are calculated to enhance his prospects should be modestly mentioned. Do not spoil your advertising by claiming too much, but let it be marked by common-sense, as well as smartness, modesty and up-to-dateness. A study of some of the advertisements of some of the well-known houses of the trade is very instructive and helpful by way of suggestion.

Working Expenses and Profits. The working expenses of a clothing business ought not to exceed 12 to 14 per cent. of the turnover, and to meet this, a minimum of 25 per cent. profit must be made on the returns, which will necessitate the addition of $33\frac{1}{3}$ to the cost (thus, cost 9d., sell 1s.,) with a higher rate on goods that are risky.

This will mean a careful watch on all outgoings, for it is only by keeping the expenses down that the tradesman can hope to succeed, and, as will be easily seen on the above estimate, he will make about 10 per cent. on his turnover for himself, which on a business doing £1,500 a year is only £150. Still, that is probably better than he would be doing as an assistant, and there is always the prospect that by energy and enterprise he may increase his business and eventually make a much more handsome income. This, however, will be possible only by constant attention to business, a careful study of the local requirements, and a courteous and obliging manner towards even the most inconsiderate customers.

Continued

THE PHYSICS OF THE WEATHER

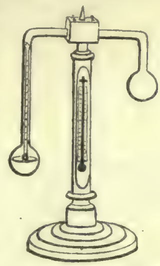
Humidity and its Measurement. Wet and Dry Bulb Thermometer. Humidity and Health. Formation of Dew. Clouds and Rain

Continued from page 1742

By Dr. C. W. SALEEBY

IN a previous section [page **1139**], when discussing the atmospheric pressure, we described the barometer, and showed how it may be used as a weather glass, the inference being that the state of the atmospheric pressure at any given time and place is the most important fact in determining the kind of weather experienced there.

But it is also very necessary, in order to understand the weather, to recognise the part played by water vapour in the air in affecting our sensations, and the obvious characters of the weather. This subject may appear to be a mere digression from the great subject of heat which we are discussing, but we must remember that temperature is one of the conditions which determine the amount of water vapour in the air, and also that the difference between such water vapour and the liquid water which we know as rain depends upon the latent heat, so-called, which is contained in the former.



DANIELL'S HYGROMETER

Water and Air. Water vapour is a constant constituent of the air, but its amount varies within very wide limits, and its amount may be expressed by the term, *the humidity of the air.* So long as the air is not saturated, it has a drying power, as everyone knows, and we have already noted that the motion of the air aids this drying power simply because it interferes with the tendency towards saturation. What we constantly appreciate by our senses is not the absolute humidity of the air—that is to say, the actual quantity of water vapour which it contains—but its relative humidity; which may be defined as the ratio of the actual density of the water vapour in the air to the possible density at that temperature—that is to say, the density of saturated vapour. Hence, on a hot day we would call air dry which really contained much more water vapour than the air which, on a colder day, we would call damp, the reason being that, in the first case, the air was much further from saturation-point than in the second case, and thus was, though absolutely much more humid, relatively less humid, and so possessed of much greater drying power.

We have already seen that in a mixture of vapours and gases each constituent exerts its own pressure independently of the others. The pressure of the water vapour in the air is thus exerted just as if nothing but water vapour were present. It depends upon its quantity and upon the temperature. When the temperature is lowered beyond a certain point some of the water vapour in the air is condensed in the form of dew, and that point is called the *dew-point.* This depends upon the pressure of the water vapour, and we have already seen upon what conditions this pressure depends.

Hygrometers. The *hygrometer* (from Greek *Hygros,* damp), must carefully be distinguished by the student from the *hydrometer,* which we have already described as an instrument for measuring the specific gravity of a liquid. The object of the hygrometer is to determine the humidity or dampness of the air, and this is usually done by determining the dew-point. The best-known hygrometer is named after Daniell. It consists of a bent-glass tube with a bulb at each end, one of which is half full of ether that has been boiled, so that the whole apparatus contains nothing but ether and ether vapour. The bulb containing the liquid ether also contains the thermometer, and is blackened. The other bulb is covered with cotton-wool, upon which a little ether is poured. This rapidly evaporates, and in order to obtain its latent heat of evaporation, as we have seen, it is bound to condense the ether vapour within the bulb. This permits further evaporation of the liquid ether in the other bulb, which, for the reason we are now familiar with, is also lowered in temperature. When the temperature falls to a certain point, dew appears on the blackened surface of the ether bulb. Thus, the dew-point can be ascertained. But the most accurate way of using the hygrometer is not to be content with one reading, but to note it, stop the cooling process, and then carefully note the temperature at which the dew disappears. The mean of the two readings may be taken as the dew-point.

Wet and Dry Bulb Thermometer. This is a thoroughly useful device so long as one remembers to keep it supplied with water. In the first place, there is an ordinary (" dry bulb ") thermometer, which ascertains the temperature of the air. Beside it, there is another, the bulb of which is covered with muslin, which is kept wet. (This is usually done by attaching a piece of lamp wick to the muslin, along which, by capillarity, water travels from a reservoir.) The rate at which the moisture evaporates from the muslin is an index to the relative humidity of the air—that is to say, to its drying power—and can itself be measured by the extent to which it lowers the reading of the wet bulb as compared with that of the dry bulb thermometer.

Needless to say, there are simpler methods than any of these for ascertaining, very roughly, not the absolute amount of moisture in the air but its relative humidity. For instance, there is the *hygroscope,* the essential part of which is

simply a human hair, which is longer when moist and shorter when dry. A piece of seaweed, also, containing a quantity of salt, acts as a hygroscope, since when the air is near saturation-point it becomes soft, whereas when the relative humidity of the air is low it becomes stiff and hard.

Relative Humidity and Health. The relative humidity of the atmosphere is a very important factor in our bodily comfort and health. The temperature of the warm-blooded animal body must be kept constant at all costs, and this is effected by a balance between the rate at which heat is produced within the body and the rate at which it is parted with to the environment. Now, we lose heat to the environment in two ways ; in the first place, by direct *radiation*—a term to be later explained ; and in the second place, as has been already hinted, by supplying the latent heat of evaporation to the perspiration, sensible and insensible, which is incessantly leaving the body. The possibility of controlling the temperature in the latter fashion entirely depends upon the relative humidity or drying power of the air, which is thus a far more important factor in our comfort than its mere temperature. Indeed, the temperature is more important in so far as it helps to determine the amount of water vapour which the atmosphere can hold than in any other way. When the amount of water vapour in the atmosphere is nearly at saturation-point, the evaporation of the perspiration becomes very slow, and hence our discomfort.

High temperatures, such as those of the tropics or a Turkish bath, can be endured with impunity only when the air is so dry, or rather when its relative humidity is so low, that we are able to part with abundance of sensible heat to the perspiration, in which it takes the form of latent heat of evaporation.

Dew. When we spoke of the hygrometer, we observed that the commonest means of ascertaining the relative humidity of the air consists in an observation of the dew-point. It is commonly stated that the natural formation of dew takes place in a precisely similar fashion to the formation of dew on the ether bulb of Daniell's hygrometer. At night, the warm earth rapidly radiates into the atmosphere the heat that it has received from the sun during the day, and blades of grass and the like, standing slightly apart from the earth, become especially cool, and cool the air in their neighbourhood, so that it can no longer hold the moisture which it could hold when it was at a higher temperature—in other words, it is cooled below its saturation temperature, and deposits its moisture. One of the most important factors in determining the amount of dew that falls is the rapidity of the radiation that occurs when the sun goes down, and this is favoured on a clear dry night, while, if the night be also still, the formation of dew is still further favoured, the lower layers of air having time to deposit their moisture before they are blown away. No doubt this is substantially true, but the botanists tell us [see NATURAL HISTORY] that plants constantly perspire (though the technical term used is *transpiration*, which is the French equivalent for our word *perspiration*), and it seems more than probable that a large portion, at any rate, of the dew does not consist of moisture deposited on the leaves of grass from the air, but consists of the water which has passed out from the leaves themselves, and the evaporation of which is prevented, owing to the cooling of the surrounding air below its saturation temperature, in the fashion we have explained. There is probably a large amount of truth in this, but, of course, the old explanation still holds entirely true for the formation of dew elsewhere than on plants. When dew freezes, it produces hoar-frost.

Fog and "Smog." In some parts of the world, where the radiation at sundown is extremely rapid, and where the air contains a very large amount of moisture, as, for instance, in tropical forests, where the dew is formed above the tree-tops, it falls like a shower of rain. This introduces us to a new subject. We have already seen that there is always a certain amount of water vapour in the atmosphere. A cloud also consists of water, but it is liquid water, formed by a lowering of the temperature of a mass of vapour-laden air, and thus having the same essential causes as dew. If the cloud be near the ground, we do not call it a cloud, but a mist, and if this be at all dense, we call it a fog. The present writer, however, strongly objects to the use of the one word *fog* to describe a dense mist, consisting merely of droplets of water, and also to describe the filth-laden products, full of smoke, particles of solid matter and sulphurous gases, which are called fogs in cities. The excellent suggestion has been made that this last should be called *smog*, in order to distinguish it from fog, which is relatively innocuous, and is essentially identical with a cloud.

Raindrops. When the very fine drops of water of a cloud join with one another, they form raindrops. Now it has been shown that, other things being equal, the smallest drops have no tendency to lose their individuality ; they are protected by their surface-tension. The cause which makes them form raindrops appears to be some kind of electrical change in the atmosphere, so that the falling of rain must be regarded as a consequence of changes in those electrical conditions of the atmosphere, a complete knowledge of which will enable us, one day, perhaps, to understand the weather, and will rescue meteorology from its present position as the "Cinderella of the sciences." Already we are able to register the dew-point, to describe clouds and thunderstorms, to study the temperature, pressure, and humidity of the atmosphere, and in large measure to comprehend the causes of winds, which depend upon inequalities in the atmospheric pressure ; and it has long been known that a certain series of changes in the sun affect the magnetic needle on the earth. But, as everyone well knows, there is much yet to be learnt before we can predict to-morrow's weather with a thousandth part of the accuracy of which astronomers can boast when they predict the return of a comet in a century.

Continued

EIGHTEENTH CENTURY PROSE

1. Being Short Studies of Defoe, Swift, Steele, and Addison, together with Illustrative Examples of their Writings

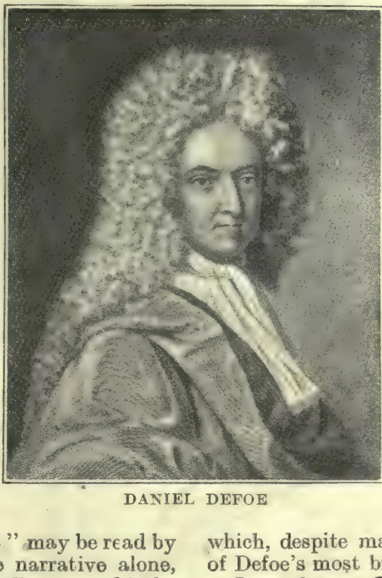
Continued from page 1642

By J. A. HAMMERTON

WHAT the prose of the eighteenth century may lack in colour and warmth as compared with the prose of the seventeenth century it gains in general smoothness, perspicacity, and correctness. It set the standard of the prose of the present day. It has been styled "aristocratic"; and this description is in the main a true one. But at the period with which we are now to deal the "aristocracy of intellect" was to a great extent employed to the furtherance of ends more practical, or at least more partisan, than literary. These ends were in part political, in part ecclesiastical, in part ethical. Thus the literature of the time must be studied in connection with its political, religious, and social history. Journalism, which, as we have seen, had its rise in the controversial pamphlets of Elizabethan and Jacobean times, received in the eighteenth century a new and forceful impetus, and the English novel assumed a more definite shape.

Daniel Defoe. To DANIEL DEFOE (b. 1661?; d. 1731) must be assigned distinction as the first of English journalists, and as the forerunner of Richardson and Fielding. To-day, save as the author of two or three books, one of them of world-wide repute, Defoe is half forgotten. In his lifetime, however, he played many parts, and over 250 distinct works bear his name. His "Robinson Crusoe" is as immortal as "The Pilgrim's Progress" or "Don Quixote." Like these two works and one other that we shall have to mention almost immediately, "Robinson Crusoe" may be read by the young on account of the narrative alone, and by elder readers as an allegory. Of the many pamphlets that flowed from Defoe's busy pen the most remarkable, perhaps, is that bearing the title, "The Shortest Way with the Dissenters," a Whig production, the plausible realism rather than the satire of which, if it was really intended as a satire, secured its author a cell in Newgate and a place in the pillory.

As the author of "Captain Singleton," "Moll Flanders," "Colonel Jack," and other works of a kindred character, Defoe stood sponsor to the novel of crime. In 1704 he started a "Review" which was the forerunner of "The Tatler," "The Spectator," and "The Rambler." "Robinson Crusoe" and the fictitious "Journal of the Plague Year" are enough to secure for Defoe pre-eminence as a master of the art of literary illusion. "To him," says Leslie Stephen, "was given a tongue to which no one could listen without believing every word he uttered." He had defects. He was curiously heedless of chronology; he was weak, on the whole, as a delineator of character. But he was an essential "realist," and if his readers would study the didactic side of his writings more, and the "Serious Reflections" of his inimitable hero in particular, the character of Defoe himself would escape in the future some at least of the aspersions that are still cast upon it. "With Defoe," says Professor Walter Raleigh, "the art of fiction came to be the art of grave imperturbable lying, in which art the best instructor is the truth. And it was to no reputed masters of romance, but to recorders of fact, biographers, writers of voyages and travels, historians, and annalists, that Defoe served his apprenticeship."



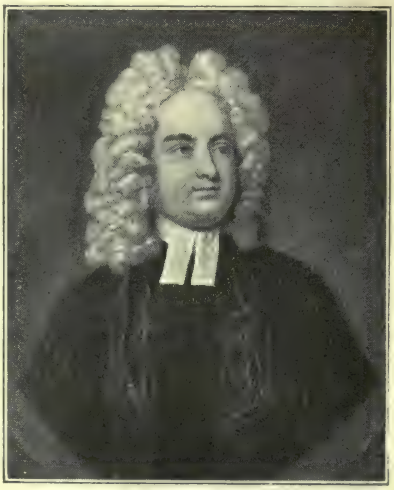
DANIEL DEFOE

No one need be counselled to read "Robinson Crusoe." The reading of this immortal fiction is in the birthright of every Englishman, though not so many are familiar with its sequel, which, not lacking in interest, is yet greatly inferior to the first and ever popular story. "Moll Flanders" ought certainly to be read and "The Journal of the Plague," but we would also urge the claims of "Colonel Jack," which, despite many inequalites, contains some of Defoe's most brilliant writing.

Jonathan Swift. As a pamphleteer JONATHAN SWIFT (b. 1667; d. 1745) affords an interesting companion study to Daniel Defoe. Swift was, however, by far the greater man. His power as a pamphleteer may be gauged by a consideration of the famous "Letters," signed "M.B., Drapier," and familiarly known as "Drapier's Letters." In these compositions he attacked the iniquitous "job" by which, in 1722, a certain William Wood, a hardwareman and a bankrupt, was granted a patent for supplying Ireland with copper coin. The "Drapier Letters" defeated this project, and though it is often said that the ensuing

popularity of their author amongst the Irish people was unpalatable to him, his bequests to Irish charities seem to negative the idea that he had no sympathy for the people amidst whom his lot was for a long time cast. Swift, it is to be feared, is largely misunderstood. Though he became a keen Tory, his indignant passion against wrongdoing raised him so much above party feeling that he offended both friends and enemies. What he scorned to do for the sake of party or for the sake of his own preferment, he scorned to do for the sake of being thought conventional in his language. The result has been misunderstanding and the keeping of admiration at arm's length. The "Tale of a Tub" is the most comprehensive example of all that is characteristic of his prose style. As sailors were supposed to throw out a tub to a whale to prevent it from colliding with their ship, so Swift thought by his "Tale" to afford such temporary diversion to the wits and freethinkers of his day as to prevent them from injuring the State by the propagation of wild theories respecting religion and politics. But his satiric genius, his fiery imagination, and his keen eye for "the seamy side" imparted to the "Tale of a Tub" qualities that disguised his avowed object and at the very outset placed an insurmountable obstacle in the way of his ecclesiastical preferment.

Satire and Self-revelation. "The Battle of the Books," which, with the "Tale of a Tub," helped to make Swift famous, takes a witty part in a controversy that was raging over the respective claims of modern and ancient literature. Something like one-fourth of Swift's most remarkable work, "Gulliver's Travels," and a great part of his other writings are debarred from general circulation on account of their coarseness. But of "Gulliver's Travels" enough is so delightful as romance as to rival both "Robinson Crusoe" and "The Pilgrim's Progress" in the estimation of young and old. Important as a satire, "Gulliver's Travels" has a distinct value as autobiography. While Defoe excelled in the art of making fiction read like fact, Swift, with the finest skill, cultivated a drastic simplicity and homeliness of style the accumulated effect of which is so formidable as to afford a permanent object lesson in the art that conceals art where the writing of nervous English prose is concerned. But the fact must not be ignored that with all its carefully calculated simplicity the English of Jonathan Swift is never pedestrian or devoid of sparkle or variety. We select as an illustration of Swift's style his "Meditation upon a Broomstick," in which he imitated the manner of the "Reflections" of the philosopher Robert Boyle. It was written for a lady who greatly admired these meditations:



JONATHAN SWIFT

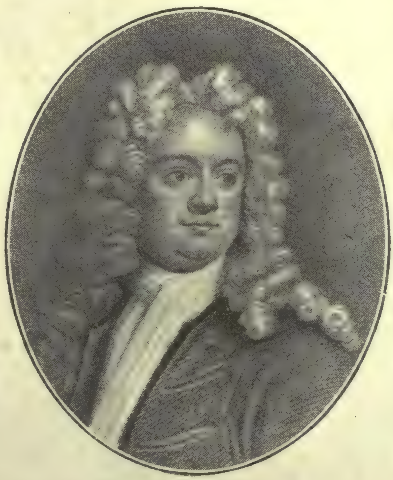
Specimen of Swift's Prose. "This single stick, which you now behold ingloriously lying in that neglected corner, I once knew in a flourishing state in a forest. It was full of sap, full of leaves, and full of boughs. But now in vain does the busy art of man pretend to vie with Nature by tying that withered bundle of twigs to its sapless trunk! 'Tis now at best but the reverse of what it was, a tree turned upside down, the branches on the earth, and the root in the air. 'Tis now handled by every dirty wench, condemned to do her drudgery, and, by a capricious kind of fate, destined to make other things clean, and to be nasty itself. At length, worn to the stumps in the service of the maids, 'tis either thrown out of doors or condemned to the last use of kindling a fire. When I beheld this I sighed, and said to myself, *Surely mortal man is a broomstick.* Nature sent him into the world strong and lusty, in a thriving condition, wearing his own hair on his head, the proper branches of this reasoning vegetable, till the axe of intemperance has lopped off his green boughs and left him a withered trunk. He then flies to art, and puts on a periwig, valuing himself upon an unnatural bundle of hairs, all covered with powder, that never grew on his head. But now should this our broomstick pretend to enter the scene, proud of those birchen spoils it never bore, and all covered with dust, though the sweepings of the finest lady's chamber, we should be apt to ridicule and despise its vanity. Partial judges that we are of our own excellencies, and other men's defaults! But a broomstick, perhaps you will say, is an emblem of a tree standing on its head; and pray what is man but a topsy-turvy creature, his animal faculties perpetually mounted on his rational, his head where his heels should be, grovelling on the earth! And yet, with all his faults, he sets up to be a universal reformer and corrector of abuses, a remover of grievances, rakes into every slut's corner of nature, bringing hidden corruptions to the light, and raises a mighty dust where there was none before, sharing deeply all the while in the very same pollutions he pretends to sweep away. His last days are spent in slavery of women, and generally the least deserving; till worn to the stumps, like his brother besom, he is either kicked out of doors or made use of to kindle flames for others to warm themselves by."

Students of Swift's life will find in his work much that reflects the shadows of his unhappy experiences. They will be especially indebted

to the "Journal of Stella" (Esther Johnson, whose tutor he was) for many valuable pages of autobiography and for many sidelights on the manners of the time.

Steele and Addison. SIR RICHARD STEELE (b. 1672; d. 1729), the friend and schoolfellow of JOSEPH ADDISON (b. 1672; d. 1709), was, like Swift, born in Ireland; but in this fact lies the sole resemblance between the saturnine Dean of St. Patrick's and the genial "scallywag" who originated "The Tatler," wrote part of "The Spectator," founded "The Guardian" and other ephemeral periodicals, and worshipped Addison as a hero. In 1709, Steele started "The Tatler" anonymously. It was a small sheet, sold for a penny, appearing three times a week, and designed to expose "the false arts of life, to pull off the disguises of cunning, vanity, and affectation, and to recommend a general simplicity in our dress, our discourse, and our behaviour." Part of "The Tatler" was devoted to news. When his pen-name of Isaac Bickerstaff, which he borrowed from a diverting pamphlet by Swift, became useless as a disguise, Steele founded "The Spectator." "The Tatler" extended to 271 numbers, of which Steele wrote 188; his friend Addison contributed 42, and they were jointly responsible for 36. "The Spectator," which was published daily, ran to 635 numbers, of which Addison wrote 274 and Steele 240. The wholesome effect of these publications on the manners and morals of the eighteenth century can hardly be exaggerated. Both the style of writing and the tone of conversation were improved as a result of their influence. It is generally conceded that while Addison's style is the more finished, Steele's is more marked by liveliness of invention. Addison usually wrote at leisure, Steele often in a "white heat." The papers took the form sometimes of moral and critical discourses, sometimes of short stories of domestic life, in the writing of which Steele excelled.


JOSEPH ADDISON


SIR RICHARD STEELE

Influence of Steele and Addison. Both "The Tatler" and "The Spectator" are remarkable for the respectful tone adopted in referring to women, though Steele was more chivalrous and less patronising than his friend. It was in "The Tatler" that, as Mr. G. A. Aitken reminds us, Steele wrote, "As charity is esteemed a conjunction of the good qualities necessary to a virtuous man, so love is the happy composition of all the accomplishments that make a fine gentleman." And in the same paper he paid his memorable tribute to Lady Elizabeth Hastings (b. 1682; d. 1739), a philanthropist and beauty, immortalised as "Aspasia" by both Steele and Congreve: "Though her mien carries much more invitation than command, to behold her is an immediate check to loose behaviour, and to love her is a liberal education." The plan of "The Spectator" was laid at a club, and in the second number, which was written by Steele, we are given the first sketches of the members. It is, as Mr. Aitken observes, a remarkable testimony to the skill of Steele's work that the characters stand out so clearly before us. The immortal baronet, Sir Roger de Coverley, is understood to be Addison's invention. "The great work of Addison and Steele was to form public opinion on matters respecting which it can hardly be said to have existed before, and to cause their readers, at a critical time in our history, to consider moral and social questions from a higher standpoint than had been their wont." As a short example of Steele's style, we may select the following passage on a theme that is of universal interest:

Example of Steele's Style. "The first sense of sorrow I ever knew was upon the death of my father, at which time I was not quite five years of age; but I was rather amazed at what all the house meant than possessed of a real understanding why nobody was willing to play with me. I remember I went into the room where his body lay, and my mother sat weeping alone by it. I had my battledore in my hand, and fell a-beating the coffin, and calling Papa; for, I know not how, I had some slight idea that he was locked up there. My mother caught me in her arms, and, transported beyond all patience of the silent grief she was before in, she almost smothered me in her embrace, and told me, in a flood of

tears, papa could not hear me, and would play with me no more, for they were going to put him underground, whence he could never come to us again. She was a very beautiful woman, of a noble spirit, and there was a dignity in her grief amidst all the wildness of her transport, which, methought, struck me with an instinct of sorrow, which, before I was sensible of what it was to grieve, seized my very soul, and has made pity the weakness of my heart ever since. The mind in infancy is, methinks, like the body in embryo, and receives impressions so forcible that they are as hard to be removed by reason as any mark with which a child is born is to be taken away by any future application. Hence it is that good nature in me is no merit; but having been as frequently overwhelmed with her tears before I knew the cause of my affliction, or could draw defences from my own judgment, I imbibed commiseration, remorse, and an unmanly gentleness of mind, which has since ensnared me into ten thousand calamities, and whence I can reap no advantage, except it be that, in such a humour as I am now in, I can better indulge myself in the softness of humanity, and enjoy that sweet anxiety which arises from the memory of past afflictions."

Steele and Addison Compared. Steele, as Hazlitt remarked, seems to have gone into his study chiefly to set down what he observed out of doors. Addison, on the other hand, drew most of his inspiration from books. But whatever the cause may be, and however much our heart may go out to "Dick" Steele, the verdict of such good critics as Johnson and Macaulay must be accepted concerning the high qualities of Addison's limpid style. Addison's sentences, according to Johnson, have neither studied amplitude nor affected brevity; his periods, though not diligently rounded, are voluble and easy. "Never," said Macaulay, "had the English language been written with such sweetness, grace, and facility." Steele excelled in sympathy, Addison was a master of irony. Not the least of Addison's services to literature was the attention he gave in "The Spectator" to Milton. These papers should be studied by all who desire to appreciate the style and value of literary criticism in Addison's time. On the whole, we read Addison to-day not so much for the value of what he has to say as for the way in which he says it. One of the most noteworthy of his contributions to "The Spectator" is the allegory entitled "The Vision of Mirza," which the writer professes to have translated from an Oriental manuscript. It tells of one who went up to the high hills of Bagdat to pray. There he met the Genius of a certain rock who opened his eyes to the vision of a great valley with a prodigious tide flowing through it. The valley is the Vale of Misery, the tide part of the great Tide of Eternity. In the midst is a Bridge—Human Life—over which multitudes are passing, and which, like the valley, is shrouded at both ends by darkness. The fairway is studded with trap doors through which passengers fall into the flowing tide beneath. The narrative proceeds:

Short Specimen of Addison's Style. "The Genius, being moved with compassion towards me, bid me quit so uncomfortable a prospect. Look no more, said he, on man in the First Stage of his Existence, in his setting out for Eternity; but cast thine eye into that thick Mist into which the Tide bears the several generations of mortals that fall into it. I directed my sight as I was ordered, and (whether or no the good Genius strengthened it with any supernatural force, or dissipated part of the Mist that was before too thick for the eye to penetrate) I saw the Valley opening at the farther end, and spreading forth into an immense Ocean that had a huge Rock of Adamant running through the midst of it, and dividing it into two equal parts. The Clouds still rested on one half of it, inasmuch that I could discover nothing in it; but the other appeared to me a vast Ocean planted with innumerable Islands, that were covered with fruits and flowers, and interwoven with a thousand little Shining Seas that ran among them. I could see Persons dressed in glorious habits, with garlands upon their heads, passing among the trees, lying down by the side of fountains, or resting in beds of flowers; and could hear a confused harmony of singing birds, falling waters, human voices, and musical instruments. Gladness grew in me upon the discovery of so delightful a scene. I wished for the wings of an eagle that I might fly away to those happy seats; but the Genius told me there was no passage to them, except through the Gates of Death, that I saw opening every moment upon the Bridge."

Addison's Merits and Defects. This is no bad specimen of Addison's style, illustrating its defects as well as its merits. He sacrificed everything to elegance; that is, to rhythm or melody of phrase. The supple movement and cadence of the above, its colour, will be at once apparent to the critical reader, but equally will the student detect such a tautological passage as in the second sentence, where "into that," "into which" and "into it" form six of a sequence of eighteen words. Addison not only shows a somewhat limited vocabulary at times, but is very apt to repeat unnecessarily his ideas and his images. The allegory from which we have quoted will furnish examples of this, and also of what is not always a fault, though usually stigmatised as such by the partisans of the pompous, rhetorical style of prose,—his looseness of construction. In the essay, this has its advantages, and helps to lightness of touch, which is scarcely possible where the writer aims at "rounded periods" or stately, slow-moving sentences. But we are inclined to think that Addison has long been something of a fetish with writers on literary style,—"Read an essay of Addison's every day" has been the reiteration of all our mentors for generations,—and that in the not very distant future, his chief interest will be historic, his influence less immediate on individual students, though there is no gainsaying its effect on eighteenth century prose.

Continued

THREE-PHASE

The Three-Phase Plan of Working. Combination of Three Currents to Produce Revolving Magnetic Flux. Induction Motors. Stator and Rotor

Group 10
ELECTRICITY
13

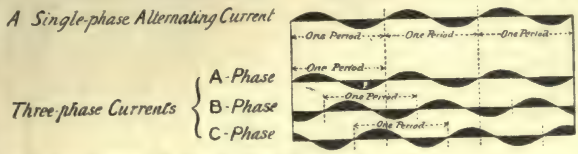
Continued from page 1661

By Professor SILVANUS P. THOMPSON

WITHIN about fifteen years a system of electric supply has come into use under the name of *Three-phase electric currents,* having certain special features and properties which have proved of great value.

Essential Features of Three-phase. In describing, on page 1357, the properties of the alternating current, it was pointed out that in the periodic changes that recur the alternating current is of zero value twice in each period. Thus an alternating current of fifty periods per second dies down to zero a hundred times a second, between the pulsations of the current. It follows that the flow of energy conveyed by such a current is pulsatory, not steady. This is analogous to that which occurs mechanically in any single-cylinder engine. There are two dead-points in each revolution—where the crank has no leverage and the piston can exert no turning effort. Engineers get over this trouble by designing engines with two or three cylinders, requiring two or three cranks.

The three-phase system of currents consists in the employment of three electric currents, which are each alternating with the same frequency, and are of equal amplitude, but which, like the pistons of a three-cylinder engine, are arranged not to be in step one with the other, but to follow one another in regular succession. The reader already knows how the pulsations of an ordinary or single-phase alternating current may be depicted graphically as on page 1362.



109. DIAGRAM OF PULSATIONS OF ALTERNATING CURRENTS

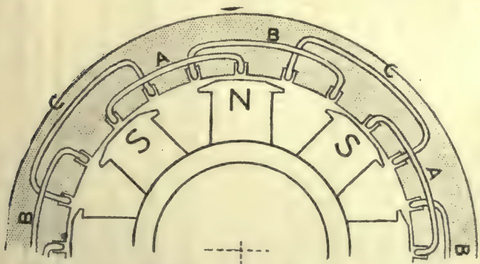
First Half-period.

0 26 50 71 87 97 100 97 87 71 50 26 0 26 50 71 87 97 100 97 87 71 50 26 0

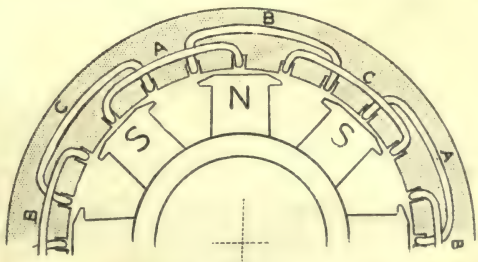
(first half: + + + + + + + + + + + ; second half: — — — — — — — — — — —)

Second Half-period.

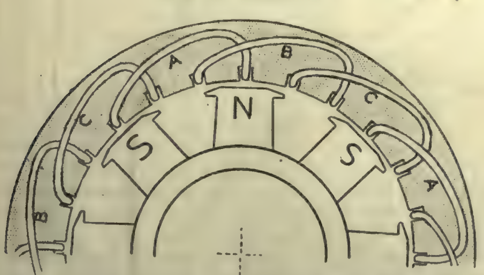
The values during the second half-period are negative, the minus sign being printed above the figures that represent the successive values.



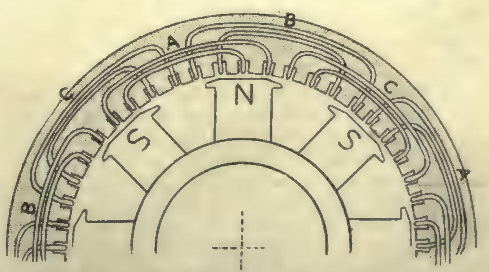
110. THREE-PHASE GENERATOR. THREE-RANGE WINDING



111. TWO-RANGE WINDING OF ARMATURE



112. THREE-PHASE ARMATURE WITH "BASKET" WINDING



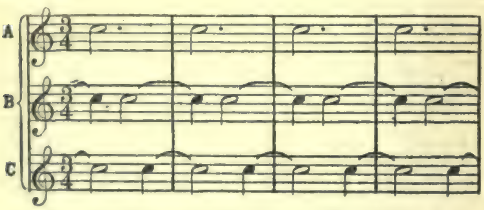
113. WINDING IN TWO SLOTS PER PHASE PER POLE

Numerical Illustration. As on page 1361, so here we may represent these alternating fluctuations numerically. Suppose a current that varies between a maximum of + 100 amperes and a negative maximum of − 100 amperes: then, if we consider the period as divided into twenty-four intervals, we may represent its successive changes during the period (lasting, say, $\frac{1}{50}$ of a second) by the numbers on the preceding page, a plan like that adopted on page 1361.

Now, in the three-phase plan, we have three alternating currents, their relations as to time being depicted in **109**. In this diagram the three currents are named A, B, and C; and inspection of the diagram will show that if time be represented by horizontal distances, each *period* being represented by an inch, since the zero of the current that is in the B-phase is $\frac{1}{3}$ of an inch to the right of the zero of that in the A-phase, it follows that the B-current is $\frac{1}{3}$ of a period out of step (and later) than the A-current.

Similarly the current in the C-phase is another $\frac{1}{3}$ of a period behind the current in the B-phase, or $\frac{2}{3}$ of a period behind that in the A-phase. But if we look a little further on in the A line we see that the next period in the A-phase begins at $\frac{1}{3}$ of an inch further to the right than the point at which the C-phase began. So the pulsations of the three currents come in regular succession, at times $\frac{1}{3}$ of a period apart (like the recurrences of the three cranks of a three-crank engine or those of a three-throw pump), in the order, A, B, C—A, B, C—A, B, C, etc.

Musical readers will perhaps better grasp the idea of the way the three "phases" of the alternations overlap one another by an illustration attempted in musical notation with three simultaneous lines of notes in three-four time, as under:



Numerically this is represented by taking the previous series of numbers, repeated three times, but each time shifted on by $\frac{1}{3}$ of a whole "period" as shown in accompanying table.

TABLE OF VALUES OF THREE-PHASE CURRENTS, ALTERNATING BETWEEN MAXIMA OF + 100 AND − 100 AMPERES

	Instant.	A-phase.	B-phase.	C-phase.
	0	0	− 87	+ 87
First Half-period.	1	+ 26	− 97	+ 71
	2	+ 50	− 100	+ 50
	3	+ 71	− 97	+ 26
	4	+ 87	− 87	0
	5	+ 97	− 71	− 26
	6	+100	− 50	− 50
	7	+ 97	− 26	− 71
	8	+ 87	0	− 87
	9	+ 71	+ 26	− 97
	10	+ 50	+ 50	− 100
	11	+ 26	+ 71	− 97
	12	0	+ 87	− 87
Second Half-period.	13	− 26	+ 97	− 71
	14	− 50	+100	− 50
	15	− 71	+ 97	− 26
	16	− 87	+ 87	0
	17	− 97	+ 71	+ 26
	18	− 100	+ 50	+ 50
	19	− 97	+ 26	+ 71
	20	− 87	0	+ 87
	21	− 71	− 26	+ 97
	22	− 50	− 50	+100
	23	− 26	− 71	+ 97
	24	0	− 87	+ 87

Three-phase Generators. To generate the three currents in these phasal relations to one another is quite simple. An alternator such as is described on page 1358 must have its armature wound with three independent set of coils, an A set, a B set, and a C set, and they must be spaced out in the slots along the periphery of the armature at distances apart equal successively to $\frac{1}{3}$ of the pitch from one north pole to the next north pole. Now, there are several ways of arranging the coils, according to the form given to the projecting end-bends. These are sometimes arranged, as in **110**, in three ranges; sometimes, as in **111**, in two ranges (one set projecting nearly straight out, while the other set is bent up); sometimes, as in **112**, where the bends overlap like wickerwork. They must, of course, be properly insulated from one another, and from the iron parts. The coils of the A-phase will all be joined up together to make the A-circuit, those of the B-phase will be joined up to form the B-circuit, and so forth. Sometimes the coils of each group are distributed in more than one slot per pole. Fig. **113** illustrates a two-slot winding, in which there are therefore six slots per pole. The large stationary armature [**82**, page 1361] has a winding of this kind.

Almost all the alternators used in large generating stations are three-phase, and nowadays they are nearly always driven either by water-turbines where there is water-power available, or by steam-turbines where coal must be burned to raise steam. Figs. **114** and **115** relate to large turbo-alternators. Fig. **114** is the stationary armature of a machine, built for a Parsons' steam turbine set by Messrs. Brown, Boveri & Co., which generates three currents of 1,560 amperes each at 370 volts from line to line, or 213 volts generated in each phase. It is therefore of 1,000 kilowatts, taking 1,450 horse-power to drive it. It runs at 1,500 revolutions per minute, and has 4 poles. Fig. **115** represents the very solid revolving field-

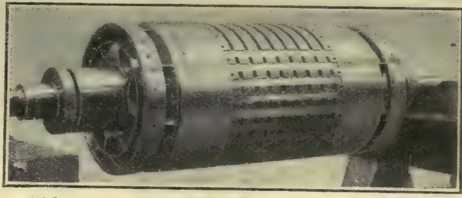
magnet used in machines of this type, the exciting windings being sunk in grooves milled out in a cylinder of solid steel. The actual field-magnet shown in **115** belongs to a smaller machine of 200 kilowatts, running at 2,400 revolutions per minute. It has only two poles, one being along the top of the cylindrical magnet, the other along its under side.

The Three Lines. From the generator there will go three lines to the place where the electricity is to be used, and every motor suitable for service on this system will have three terminals to be connected to the three lines. Lamps also may be used, and these (with due regard to voltages concerned), may be connected across either from line to line, or from each line to a common junction J as in **116**. No earth return or return line is needed, and if equal numbers of lamps are used in each phase, the three currents will be of equal virtual value. The reason why no return line is needed is because each line in turn acts as a return line to the others. This is seen by reference to the table, which is drawn up for the case where each of the three currents is of the maximum value of 100 amperes, and where, therefore, the virtual value [see page 1361] of each of the three currents is 70·7 (or say 71) amperes. Looking, for example, at line 6 of the table, we see that at the instant when 100 amperes are going out along line A, the value in B is − 50, and in C is also − 50 amperes, so that the lines B and C are, at that moment, each bringing 50 amperes back to the generator. A moment later, when the A current has dropped

115. STATIONARY ARMATURE OF TURBO-ALTERNATOR (Brown)

to 97 amperes, 26 amperes will be coming back by the B line, and 71 by the C line; while at the next moment (instant No. 8) the 87 amperes are going out along the A line, the whole 87 coming back by the C line, and so forth.

Connecting up Three-phase Windings. There are two principal ways of connecting up the three windings. In the way called Y-grouping, or *star-grouping*, the three circuits start from a common junction J, as in **117**, and their three ends go to the three lines. In



114. ROTATING FIELD-MAGNET OF TURBO-ALTERNATOR (Brown)

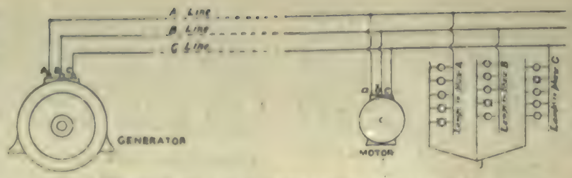
this case, the voltage between any two of the lines is equal to $\sqrt{3}$ (*i.e.*, to 1·732) times the voltage generated in any one of the three circuits of the generator, and the current in each line is the same as the current in each circuit. In the other way, called Δ-grouping (delta-grouping), or *mesh-grouping*, the three circuits are joined up with the beginning of one coil to the end of the next, as indicated diagrammatically in **118**, and the three lines are joined to the three meeting-points. In this case, the three voltages between the lines are the same as the voltages generated in the three circuits, but the line currents are now each 1·732 times as great as the current in each circuit. Thus, suppose a machine to be designed with so many turns in each armature circuit as to generate 1,000 virtual volts, and of such a thickness of copper conductor as to carry 100 virtual amperes at full load, then, if the Y-grouping were adopted, the lines would receive 100 amperes each, with 1·732 volts from line to line; while if Δ-grouping were adopted, the lines would receive 173·2 amperes each, with 1,000 volts between the lines. In both cases the output will be 1,000 × 100, that is, 100,000 volt-amperes, or 100 kilo-volt-amperes for each phase, that is, 300 kilowatts [p. 1363], if the currents do not lag.

Three-phase Conductors. Where the lines are carried overhead for transmission of the current, it is usual to carry them on three insulators mounted on poles or iron standards, as in **119**, the insulators being arranged as at the corners of an equilateral triangle. For underground conductors, cables are used, having three separately insulated cores, as shown in section in **120**.

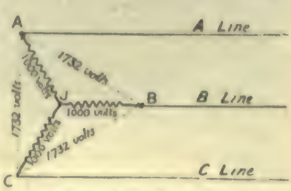
Three-phase Transformers. To transform three-phase currents from a high voltage down to the low voltage needed for lamps or motors, one may employ either three similar transformers—one in each phase—or else a special three-phase transformer having three sets of primary windings, and three sets of secondary windings. Such a three-phase transformer is shown in **121**.

The three windings of each side may be connected, as desired, in either Y or Δ-grouping.

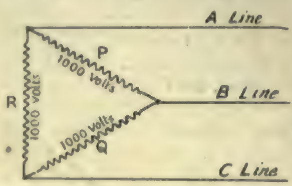
Three-phase Motors. The great reason for adopting the three-phase system is its suitability for driving three-phase motors; for by suitably combining coils in an armature or stator the interaction of the three currents produces a rotating or progressive magnetic field, and a suitable rotor placed in this field is set powerfully into revolution without the need of connecting it in any way into the circuit. We shall be helped to understand how this comes about if we regard 122 to 124, and compare them with the table of values given above.



116. A THREE-PHASE GENERATOR SUPPLYING MOTOR AND LAMPS

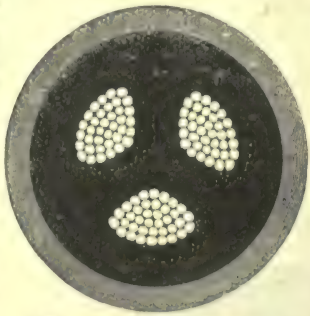


117. THREE-PHASE Y-GROUPING

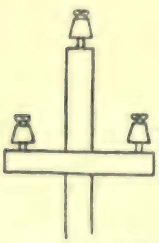


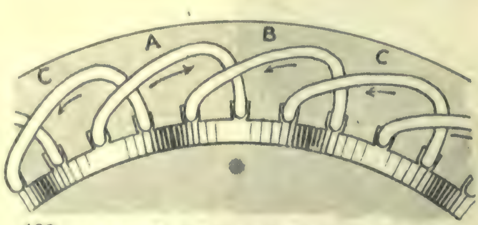
118. THREE-PHASE Δ GROUPING

Revolving Magnetic Field. Suppose an armature wound with three sets of coils laid in slots, just as shown in 112, those coils being in three phases, A, B, and C. Now, suppose that at the moment under consideration the current is at its maximum—say, 100 amperes—in the A coils. At that moment, as seen from the tables, the currents in the B and C coils will each be − 50. The arrows [122] show the direction, + being a circulation to the right, − to the left. Then, the circulations of these currents will conspire to produce a magnetic field which will be strongest right under the middle of the A coils. An instant later, the A-current will have died down to + 97, while the B-current will have become − 26, and the C-current − 71. This will have the effect of shifting the resulting magnetic field a little to the right. After another instant, A will have died down to + 87, B will have become 0, and C will be − 87, and the magnetic field will have shifted a little further. This is shown in 123. At the next stage, A will have become + 50, B will be + 50, and C − 100, and the flux, which at first was under the middle of A, will now be a whole tooth to the right, as in 124. When A has reversed to − 50, B will be + 100, and C will be − 50, and by that time the magnetic field will have shifted so that the strongest part of it will be under the middle of the B coil.

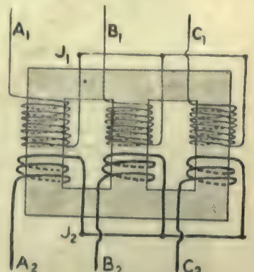

120. THREE-PHASE CABLE (SECTION)

The Stator. In this way, though the stator and its coils stand still, the effect is produced of a revolving multipolar magnet. The magnetism revolves, though the metal framework stands

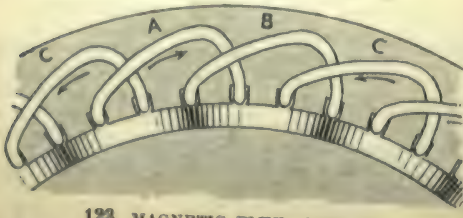

119. POST FOR THREE-PHASE LINES



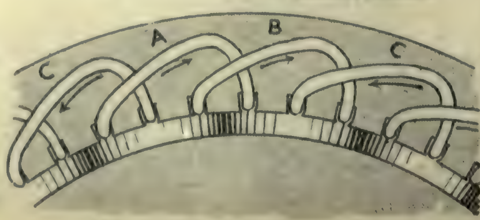
122 MAGNETIC FLUX DUE TO THREE-PHASE CURRENTS, CASE I



121. THREE-PHASE TRANSFORMER

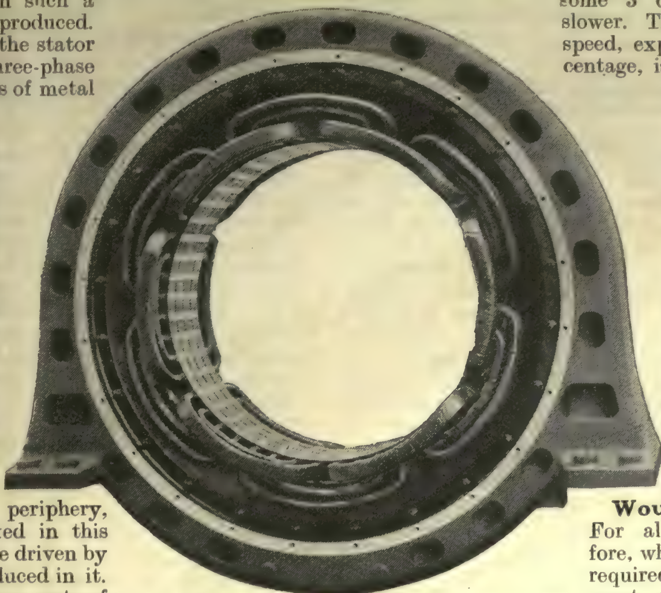


123. MAGNETIC FLUX, CASE II



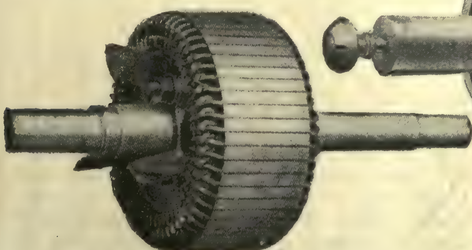
124. MAGNETIC FLUX, CASE III

still. Such a field is sometimes called a *Ferraris field*, in honour of Galileo Ferraris, who first showed how, in such a field, rotation is produced. Fig. **125** depicts the stator of an 8-pole three-phase motor. Any mass of metal placed in a revolving magnetic field tends to revolve round after the field by reason of the electric currents induced in it by the invisible magnetic lines as they sweep round it. Hence if a rotor or revolving part be provided, consisting of an iron core having closed coils embedded in its periphery, it will, if inserted in this revolving field, be driven by the currents induced in it. As the revolving part of such motors receives its currents by *induction* instead of conduction, and is entirely disconnected from the primary circuit, such motors are often called *induction motors*.



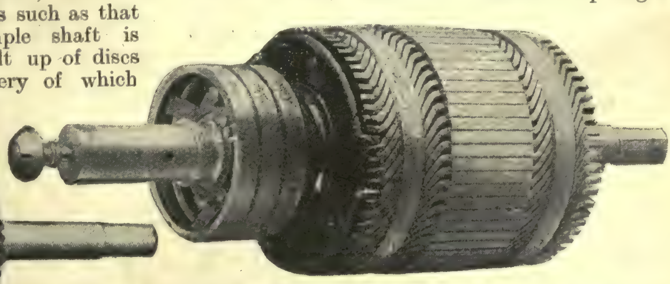
125. STATOR OF 8-POLE INDUCTION MOTOR
(Dick, Kerr & Co.)

The Rotor. For small motors, the suitable rotor to put into such a field is such as that depicted in **126**. On a simple shaft is mounted an iron cylinder, built up of discs of sheet iron. in the periphery of which are embedded a number of copper rods or conductors, all joined together at each end. Such a construction is described as a *squirrel-cage* rotor. It needs no connection to the outside circuit, but receives its currents wholly by induction. In fact, the action is much like that of a transformer, the stator coils acting as a primary winding, and the bars of the squirrel-cage acting like the secondary coils. The squirrel-cage runs round, always trying to overtake the revolving magnetism, but never succeeding. In fact, it runs some 3 or 4 per cent. slower. This difference of speed, expressed in percentage, is called *the slip*. At no-load, the slip is less than 1 per cent. As the load on the motor is increased, the slip increases, the driving forces being proportional to the slip. Motors with squirrel-cages, though so very simple, do not exert any great torque, or turning effort, at starting.



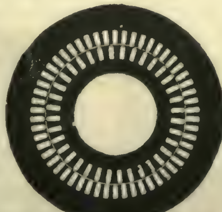
126. ROTOR OF INDUCTION MOTOR
(Witting, Eborall & Co.)

Wound Rotors. For all cases, therefore, where a motor is required to exert a great starting effort, the rotor is of a different kind. The iron core is provided with slots in which is wound another three-phase winding, the ends of which are connected to three slip-rings mounted on the shaft, as in **127**. On each slip-ring a brush makes a sliding contact, so that connection is made with three sets of resistance-circuits. The effect of thus introducing resistance into the rotor is to increase the starting effort. But as the resistance wastes some power by growing hot, arrangements are made to cut it out as soon as the motor has started, and in running on load the rotor circuits are simply closed on themselves.



127. WOUND ROTOR OF INDUCTION MOTOR
(Witting, Eborall & Co.)

Motor Stampings. The bodies of three-phase motors are constructed of stampings [128] of thin sheet iron or mild steel about $\frac{1}{60}$ in. thick. The slots for the windings are stamped out at their peripheries.



128. STAMPINGS FOR INDUCTION MOTOR
(Sankey)

Continued

Group 2
ART
12
Continued from page 1676

ARCHITECTURE

Branches of Knowledge Essential to the Architect. "Taking Out the Quantities." Tenders. Cubing. The Architect's Scale of Charges. Examinations

By GASPARD TOURNIER

THE great number of very diverse sciences and arts which the student finds are involved in the functions architects have to deal with in their daily practice generally very much bewilder him at the start.

In its supreme essence Architecture is an Art—the planning of structures with lucidity, and the clothing of them with beauty restrained by fitness and the physiognomy of type. But the process to be followed for securing effective execution entails contact with many sciences and crafts and executive business processes, including a capacity for administrative management.

Knowledge Necessary to an Architect. Thus are embraced so many opposite branches of knowledge that he is disheartened, and doubts his ability ever to become personally proficient in them all. As a matter of fact, no architect is so; and it is essential, at the outset, that the student be helped to analyse the subjects, so as to enable him to group them into three distinct divisions: (1) Those he must know thoroughly and practically; (2) those of which he need thoroughly know the radicals only; and (3) those which exclusively call for the critical faculty—*viz.*, where his function is to supervise work done by others.

For, after the first main conception of a building, most of what remains has to be left to other brains—each working out its part under his supervision and master grasp.

We have found the student is much helped in this primal analysis by a condensed history of how a building is erected, from the first inceptive scale sketch to the final completion of the structure.

It should be remembered that all architectural drawings are done to scale; the first ones usually to a scale in which ⅛ in. stands for each foot of real length. Plans of each floor are made, and, to show how they fit over each other, sections are drawn representing what would be seen if the building be cut open in vertical slices and cross slices. The elevations of all sides are also drawn to the same scale, and, to show how these combine or join on to each other, perspectives are made for the client to judge the result.

The Specification. As every detail of a building cannot have a drawing made for it, all that which is not indicated or self-evident on the drawings done is described in a document called a Specification. Speaking generally, this consists of a description of all that the contractor and his men are called on to do, or supply, for the money agreed on. It stands in the place of what the architect would verbally say if he were present all day directing the building proceedings. It should not uselessly describe what is obvious, nor what the drawings indicate, yet clearly state everything else which will be necessary for the structure finished in its integrity. For if anything is forgotten the builder will claim payment for it beyond what he has agreed upon in his contract.

Thus the architect starts with the foundations, specifying that the site must be dug out and carted away for basement, and the trenches for concrete foundations under the footings of the walls are set out at levels indicated on the drawings. The composition of the concrete required is described; and so forth for every act next involved.

This leads the specification to become divided into a set of chapters, one for each of the representatives of the trades or crafts which have to be called in as the building advances —*viz.*, excavator, bricklayer, mason, smith and founder, carpenter and joiner, slater, plasterer, plumber, glazier, ironmonger, gas-fitter, painter, paperhanger, etc.

Scheduling Materials. On the completion of the specification it is, together with the drawings, subjected to a process called "taking out the quantities." This consists in scheduling, item by item, the quantities of material and labour which will be required for the erection of the building. These are set against blank money columns for the contractor to fill in his estimated price for each item. The whole is called "The Bill of Quantities." Copies of the bill are given to each contractor who wishes to tender for the work, and thus the lowest total price for it is ascertained.

Difference in Tenders. Students, as well as clients, are often puzzled at the great difference between the highest and lowest tender which repeatedly occurs. This is due to many causes. Builders are differently circumstanced. Some occasionally give very close prices to keep their staff employed over slack times in their own case; others are in a better position to quote low prices for certain materials which they are favourably placed for buying, or have in stock. The relative power of economising machinery is also a factor, and, with many items, the uncertainty as to the cost of workmen's time.

Thus, a builder's business has always an element of speculation in it. But the more clearly everything is indicated by the architect, and the more carefully every item is noted in the bill of quantities, the more the arrival at a rational price is helped.

For a clumsily written specification and imperfect drawings lead to random records in

the bill of quantities, and thence to gamble-prices on the part of the builder to cover misconceptions he may make of what may be ultimately required.

But although it is practically impossible for an architect to foretell to his client what the lowest tendered price for a building will be, he must, of course, form a reasonably near idea in the course of his planning, or his scheme will hopelessly differ from the sum the client can spend.

Method of Cubing. In small jobs the architect must go into each item of cost as the builder does, but in large works the method followed is what is called "cubing." Take any building executed within recent years, with the details of which you are familiar, to the drawings of which you have access, and the total cost of which you know. Find the number of cubic feet this entire building occupies as one block, including spaces in rooms and corridors, etc., as if it were a solid lump. Then divide the total cost of the building by the total cubic feet, and the result obtained is a safe guide, per cubic foot, for any building of the same type you may have to design. It is remarkable how nearly the two will approximate.

Thus, suppose you have to design a block of municipal offices, and you have in your mind an existing block of the same type of design which you know came out at one shilling per cubic foot. Price your new building at the same rate per cubic foot.

For a church, a business block, a country house, or any other building, cubic units are obtained in the same way.

The Quantity Surveyor. The taking out of quantities always used to be done by the architect or in his office, and this is still often done particularly in the provinces; but in modern times there has arisen a quite separate profession—that of a quantity surveyor, who devotes his whole time to it and takes the responsibility.

His general charge is 2½ per cent. on the cost of the building, the sum being usually paid to him direct by the builder, who allows for it in his estimate. In that case, the transaction not being direct to the client, vexatious litigation is liable to occur when the idea of building is abandoned before its erection. The quantity surveyor is then in a difficulty as to the person from whom he is entitled to claim payment. The architect should always protect himself by seeing that the client is made aware of the quantity surveyor's exact position.

It is a growing custom for the quantity surveyor to write the specification from notes given by the architect. Whether these two documents are written in an architect's office or not, when he has reached to any degree of professional practice he seldom does them himself, but it is essential that the student should be thoroughly familiar with them.

Bill of Quantities. When the contractor signs the agreement to execute a structure at the agreed price, he deposits with the architect the actual copy of the bill of quantities he has filled in, with the prices of every item scheduled therein, thus showing exactly how he arrived at his total figure. This is kept sealed till the end, when the quantity surveyor goes over the job and measures all the additions and omissions which may have arisen, the cost for which is decided by the rates for corresponding types of work occurring in the original bill of quantities. It is very liable for additions to exceed omissions through oversights by the architect, and when a client finds that the total cost has come to much more than he had prepared himself for, friction is caused unless the extras are due to additions for which he himself asked. There have been occasions when the exceeding of an estimate has led to the loss of a client's future goodwill—a client for whom the architect may have erected a building otherwise faultless. This shows that next to capacity for good planning, elevational designing, and construction, a student should strain his utmost to acquire ability in the business and documentary branches, so as to guard against such casualties.

To cover a reasonable number of unforeseen items, it is usual to add in the specification a provisional sum for them, and likewise sums under the head of auxiliary subjects, which cannot be specified at the outset in detail; as also sums which will later on be subjects for separate sub-contracts, such as mosaic floors, stained glass, and others.

Supervision during Building. The builder having signed the agreement the work of erection is begun.

As constant supervision by the architect on the site would be an undue claim on his time, there is, in the case of all buildings of any magnitude, a clerk of the works engaged to be always there to verify the correctness of all work and the quality of all materials. It is a position which demands very efficient practical experience. His salary is paid by the client.

During the progress of the work many further drawings are made beyond the original contract ones, such as details of sundry parts and full-size drawings of mouldings, etc. It is in doing these that the real quality of the initial drawings and documents becomes apparent in the absence of unforeseen errors to be remedied and forgotten items to be supplemented.

The contractor is paid in instalments, on the certificate of the architect, usually in drafts of about 80 per cent. of the cost of work done, the balance being retained till a stated period after completion, to verify the integrity of the structure and to give time for the quantity surveyor to measure and price the extras and omissions.

Architect's Scale of Charges. The scale of charges for an architect's services is generally recognised to be that issued by the Royal Institute of British Architects, but there is no Statute to enforce these terms. It is usual for architects, at the outset, to give a copy of this scale to a client and make it a personal agreement between them; and all architects of standing are agreed among themselves to work at no lower scale. Its main terms are 5 per

cent. on the cost of the executed building and 2½ per cent. on the estimated cost of work which has reached the stage for execution, but is not executed. Certain items, such as travelling expenses, are extra. In matters of personal time—such as attendance at law courts, visiting sites for opinions thereon—his charge per day depends on his standing in the profession. The minimum is three guineas per day.

It may be mentioned that 5 per cent. is not so remunerative as the uninitiated may think, since as much as half of that is often paid out for staff expenses. And so an auctioneer is often paid more for the momentary service of selling a building under the hammer than the architect actually receives for the complex work of designing it and seeing to its erection.

An Unlicensed Profession. The public often express astonishment that a vocation involving such great risks to life through faulty construction, and loss of vast sums through ignorant designing and bungling management, is not restricted by the Government to *diplomed* men. The question of doing so has long been debated, but the difficulties of drafting such an Act are many, and, as yet, the most advanced countries for State protection in all things—*viz.*, Germany, France, and America, have not done so.

Examinations by the Royal Institute of British Architects. But meanwhile the Royal Institute of British Architects, which is the chartered and recognised head of the profession, has organised an examination, compulsory on those seeking admission as Associates, and the curriculum for this test has become the standard guide to an architect's education.

It consists of three stages—Preliminary, Intermediate, and Final—and a scheduled digest of them is given in the Table below.

Examination by the Society of Architects. The Society of Architects also holds an examination, but its status is more recent, and does not carry with it the prestige of the Institute.

The following notes give an idea of the radius of proficiency asked for under each head:

Preliminary Examination. 1. Tests for accurate spelling and punctuation, and a clear, well-formed handwriting. No grammatical questions are asked.

2. An essay to test capacity for observation and lucidity in expressing ideas; one topic to be chosen from a set which is given, such as "A Cycling Tour," "The River Nile," "The Importance to an Architect of a Knowledge of the Principles of Hygiene," "Observations on the Work of Some Distinguished Architect of the Past."

3. Arithmetic up to decimal fractions and compound proportion.

4. Algebra up to simple equations.

5. The two first books of Euclid; to be well mastered, as questions put do not always name theorems from which they are evolved.

6. A general knowledge of the geography of Europe, and a more detailed one of the British Isles.

7. English history from the Norman Conquest to the end of the Tudor period.

SCHEDULE OF EXAMINATIONS FOR BRITISH ARCHITECTS

Age Limits.	Examining Body and Time and Place of Examinations.	Preliminary Examination. Obligatory Subjects.	Preliminary Examination. Alternatives at Option.	Fees.
None.	**The Royal Institute of British Architects.** June and November.	(1) Writing from dictation; (2) English composition; (3) Arithmetic; (4) Algebra; (5) Elements of Plane Geometry; (6) Geography; (7) English History; (8) Elementary Mechanics and Physics; (9) Freehand Drawing from the round	(10) One language to be selected from Latin, Italian, French, or German. One from the two following subjects: (11) Geometrical Drawing and Drawing to Scale; (12) Elements of Perspective	£2 2s.
		Intermediate.		
19 years or over	At 9, Conduit Street, Regent Street, W., London. And at provincial towns having architectural societies allied to the Royal Institute of British Architects when a sufficient number of candidates make it feasible	(1) Classic Ornament; (2) The Characteristic Mouldings and Ornaments of each period of English Architecture from A.D. 1000 to A.D. 1550, with their application; (3) The Orders of Greek and Roman Architecture; (4) The History of Mediæval and Renaissance Architecture in Europe; (5) Theoretical Construction and Strength of Materials; (6) Descriptive Geometry, the Projection of Solids; (7) Elementary Applied Construction; (8) The Nature and Use of Ordinary Building Materials		£3 3s.
		Final.		
21 years or over		The designing of buildings. A *competent* knowledge of the styles of Architecture and their details, and a *thorough* knowledge of a *special* style selected by candidate, the choice given being either (*a*) Classic and Renaissance, or (*b*) Mediæval. No further subdivisions are allowed. A full knowledge of the properties of Building Materials and their application to building; also Construction in all departments of building (including iron and steel work) and in relation to health, drainage, water supply, ventilation, lighting and heating; specification writing and estimating; the measurement and cost of building work; the conditions for contract; shoring, underpinning, and dealing with ruinous and dangerous structures		£4 4s.

8. The questions put here are within the sphere covered by ordinary college elementary text-books. Nothing is asked involving advanced questions or trigonometrical calculations.

9. Drawing from the cast of an ornament given. It is not elaborate, and the two hours allowed are ample. Anyone who has done a reasonable amount of drawing at school should be able to qualify easily for this subject if he is at all fit to choose architecture as his life's work.

10. In the language chosen, the main question is a test of good *translation into English ;* the grammatical questions are easy. There is no oral examination in this or any of the subjects in the Preliminary Examination.

11. Geometrical and scale drawing. A fair proficiency in rule drawing, and some knowledge of building construction, is added, such as is given in the first part of polytechnic text-books on elementary building construction.

12. The lesson on Perspective [see page 595] fully covers this subject.

Candidates are exempted from any of the above subjects if they have already taken them successfully in the following examinations :

Matriculation examination of English or Colonial Universities, or any local examinations conducted by them ; also those of the Central Welsh Board, the College of Preceptors, the Board of Education, South Kensington, or any other which the authorities at the Royal Institute of British Architects deem satisfactory.

Intermediate Examination. Before admission to sit at this examination, the student must submit drawings made on a set of nine double-elephant sheets 40 in. by 27 in.

On sheets 1 and 2, examples, one on each sheet, of any two of the orders of architecture to be selected from the Doric, Ionic, or Corinthian done in outline with the ornament filled in. Each order to show two columns, with entablature over, done to a scale in which the height of the columns shows not less than 10 in. on paper, and the details to three times that scale. On sheet 3, details of classic ornament from the round. On sheets 4 and 5, examples, one on each sheet, of any two periods selected from the following three : "Early English," "The Decorated," or "The Perpendicular," exemplified by features such as a door, a window, or an arcade, done to scale with plan elevation and section, and with details and ornaments enlarged. On sheet 6, mediæval ornament, drawn freehand from the round. A description of the afore-named sheets must accompany them, written on foolscap. On sheet 7, a diagram of a timber-framed roof truss, 30 ft. span, with nature of the strains indicated, and the ironwork and junctions drawn to a scale of 1½ in. to the foot, in isometrical projection, and dissociated. On sheet 8, details of floors, one of framed timber, another of combined iron and timber, and a third of a fire-resisting floor ; size of floor, 30 ft. by 20 ft., drawn to ½ in. scale. On sheet 9, details of joiners' work indoors, windows, and fittings, 1 in. scale, with mouldings and framing to a larger scale.

Some of these sheets can be exempt in cases where drawings regarded as equivalent have been done for or in other institutions, and may be substituted for them; but this procedure is not to be recommended. The essential use of all such work is to acquire *thorough* skill in draughtsmanship and the *memorising* of elemental shapes, out of which personal designing afterwards evolves ; and the more this is done the greater the facility acquired. As ready draughtsmanship is much to be desired, it will not do to be chary of time and energy in the attempt.

Scheduled Heads of Subjects. Coming now to the scheduled heads of subjects in the Intermediate Examination, heads 1 to 4 refer to the art of architecture ; 5 to 7 touch on technical construction. Under heads 1 to 4, strictly speaking, you are not called on to "design" anything, but to show, by drawing and description, that you have memorised as well as grasped the shape, features, and historic type of each style of architecture and ornamentation of the periods named. To read history and note the differences in the physiognomy of its buildings and the origin of those differences for descriptive purposes is not so difficult, but the drawing of those buildings and the analysis of their features from memory is a work calling for very much practice. You will be asked such questions as : "In what position was statuary (as apart from low relief sculpture and ornament) used externally on classic temples ? Illustrate your remarks by sketches, and give your views as to the reasons for placing it in those positions." "Sketch, in elevation, to 1 in. scale, the cap and base to columns of a nave arcade of the first half of the twelfth century (English). Ditto of the first half of the fourteenth century." "In comparing the architecture of the Renaissance period of Florence with that of Rome and Venice respectively, what difference would you remark ? Give a sketch of the elevation of an Italian palace of that period." "Describe architecturally, one of the following churches : Westminster Abbey, Canterbury, or Durham Cathedral. Illustrate your description by sketches."

For these examination heads, see textbooks given at the conclusion of this course, as also for heads 5 to 7.

After the written examination, an *oral* one is held. It will not break any new ground, but be within the compass of what has preceded, including questions arising from the nine previously submitted sheets of drawings.

Many otherwise good students fail here from sheer nervousness. The faculty of expressing your thoughts before men, under all circumstances, in board rooms, law courts, and public assemblies, is one which architects are constantly called on to do, and the student cannot start too soon to acquire it by joining a debating society, and talking on some subject till fluency of expression is habitual.

Continued

Group 5
CHEMISTRY
13
Continued from page 1723

THE GREAT LAWS OF CHEMISTRY

The Laws of Atomic Heat, Valency, and the Conservation of Matter. Radium: its Properties and the Modification of Physical Theories it Causes

By Dr. C. W. SALEEBY

HAVING completed, as far as possible, our study of the facts of inorganic chemistry, we are now in a position to review the great laws of chemistry, some of which have already been discussed. Very early in the course, for instance, we had to refer to the Periodic Law [page 400], which was a sort of curiosity a decade or two ago, but which the recent study of the atom, the discovery of the rare gases of the air, and other advances in chemistry have elevated to the very foremost rank amongst chemical truths.

Molecules of Gases. We have also made brief reference to certain of the laws of compounds, such, for instance, as the law of fixed proportions. In this and the course on PHYSICS, reference has already been made to Boyle's law, which states that the volume of a gas at a uniform temperature is inversely proportional to the pressure to which it is exposed, and also to the law which most commonly goes by the name of Gay-Lussac, that the volume of a gas increases, if the pressure be constant, by one two hundred and seventy third part of its volume at 0° C. for each rise of one degree centigrade. From these laws it has been possible to deduce another, which goes by the name of Avogadro, and which states that, given equal temperature and pressure, equal volumes of all gases contain equal numbers of molecules. This is one of the most remarkable and important laws in the whole of physics or chemistry. It constitutes the only possible way of explaining the laws of Boyle and Gay-Lussac. This law states nothing whatever about the size of the molecules of various gases—a size which is undoubtedly different in each case from all other cases, but merely asserts that all gaseous molecules under equal conditions of temperature and pressure occupy the same amount of space.

The Law of Atomic Heat. To these laws one more must be added, which commonly goes by the name of two French chemists, Dulong and Petit. It may be stated in several ways, as, for instance, that the atomic weight of any element multiplied by its specific heat [see PHYSICS] is the same for all elements. This figure or *constant* is known as the atomic heat. This law implies that precisely the same amount of heat is required in order to raise through one degree of temperature equal numbers of atoms of different elements in the solid state.

This law and the law of Avogadro are in entire accord with the kinetic theory of gases, which has been fully discussed in the course on PHYSICS.

We have frequently had to observe the fact that the elements unite with one another in very definite proportions, and we have employed such phrases as *one-handed* and *two-handed*, in order to explain, for instance, the fact that it requires, as we have said, two one-handed atoms of hydrogen to unite with one two-handed atom of oxygen, in order to form water (H_2O). Chemists have introduced the word *equivalents* in order to express certain of the facts of *valency*. They describe as the equivalent of an element that proportion by weight which will combine with or replace one part by weight of hydrogen. The facts of water lead us to observe, for instance, that, in the case of water, at any rate, 8 is the equivalent of oxygen.

The Laws of Valency. Now, by the word valency we describe the number of atoms of hydrogen with which any element will combine, or which the element will turn out from one of the compounds of hydrogen. This is as good as to say—as the reader will see if he thinks about it—that the valency of an element can always be ascertained if we divide its atomic weight by its equivalent. For instance, in the case of water we have seen the equivalent of oxygen to be 8, while we know its atomic weight to be 16; thus, its valency in the case of water is 2, or, to use our old metaphor, it is two-handed.

But if we remember the case of hydrogen peroxide, H_2O_2, we see that an element may have more valencies than one; sometimes it may act as if it were one-handed, but at other times as if it were two-handed. The rule, however, is that the compounds formed with one particular valency are much more stable than those formed with any other valency.

Valency and the Periodic Law. Until quite recently, only a few months ago, indeed, it was scarcely possible to say any more about valency than has already been said. We could simply observe the facts and state them. It seemed absolutely impossible to explain them in any way. One curious circumstance, however, could be observed, which was that valency seemed to be hinted at in the periodic law. Taking the groups of the elements in sequence, we found that the typical members of group one were one-handed, or monovalent; those of group two were two-handed, and so on. It was not stated that this is invariably the case, but it is too nearly the case to be without significance. Furthermore, as we have already noted, the rare gases of the air were found to fit into the table of the periodic law, constituting a zero group which, if there be anything in the group arrangement of valencies, ought to have no valency at all. And this is precisely what was found. Despite innumerable experiments, these gases are found to be incapable of entering into combination with each other or with any other element; they are *no-handed*.

The very recent work which has been done by Professor J. J. Thomson, of Cambridge, and his fellow-workers is now going far, however, to make valency intelligible, and especially to unravel the real significance of the remarkable manner in which the periodic law respects the facts of valency. To this subject we must return when we have discussed, so far as may be possible, the wonders of radium, radio-activity, and the new chemistry.

The Conservation of Matter. On page 61 we referred very briefly to the doctrine of the conservation of matter, which asserts that in all chemical transformations and combinations no matter is ever lost or annihilated, appearances to the contrary notwithstanding. This is by far the most important of all the great laws of chemistry—fundamentally important to the chemist, and of equal importance for philosophy. The assertion of the chemist is that, whatever process occurs to change the distribution of matter or its forms, no matter is ever lost. When we burn a candle, it would seem that something is annihilated, but it is not so. If we collect the products of combustion, remove from them the oxygen with which the constituents of the candle have combined during the process of combustion, and weigh them, we find that nothing has been lost. We also find—and this is of precisely equal importance—that nothing has been gained. There has been neither annihilation nor creation.

Let us see now why this proposition is so fundamental. The reason cannot be better stated than by Herbert Spencer in "First Principles": "Could it be shown, or could it with reason be supposed, that matter, either in its aggregates or in its units, ever becomes non-existent, it would be needful either to ascertain under what conditions it becomes non-existent, or else to confess that science and philosophy are impossible. For if, instead of having to deal with fixed quantities and weights, we had to deal with quantities and weights which are apt, wholly or in part, to be annihilated, there would be introduced an incalculable element, fatal to all positive conclusions."

Men once believed that things could vanish into nothing or arise out of nothing, or thought that they believed it. It is quantitative chemistry which has shown that in all chemical processes the law of the conservation, or the indestructibility, of matter is observed.

A New Statement Necessary. So far as all ordinary chemical processes are concerned, this law holds true to-day. But we cannot now close the discussion of it thus. This law it was that led Clerk-Maxwell to coin his celebrated phrase describing the atoms of matter as the foundation stones of the physical universe, which have lasted since the Creation, unbroken and unworn. No power in the universe could destroy an atom. If all the other atoms in the universe were ranged against it, it would survive their attacks. But nowadays we are all aware that Clerk-Maxwell's conception of the atom is obsolete. Of this there will be no remaining doubt when we have proceeded to the discussion of radio-activity. Atoms are not like foundation stones; they consist of systems of almost infinitely smaller units, known as corpuscles or electrons. These systems vary in stability, though those with which we are familiar are probably the most stable that have survived, while less stable atomic systems have disappeared, in accordance with the law of the survival of the fittest, which is now believed to obtain amongst atoms as amongst organisms. If we are to adhere strictly, then, to the law of the conservation of matter as a fundamental dogma of chemistry and of philosophy, we must let the atom go and must turn to consider the electron or corpuscle.

Conservation of Energy. Now, the truth appears to be, as was, indeed, long ago discerned by the genius of Spencer, that the law of the conservation of matter must be regarded as merely a convenient aspect of a much greater law—the law of the *conservation of energy.* The belief in the indestructibility, or conservation, of atoms has had to go, since radium demonstrates to our actual vision the destructibility and impermanence of atoms. Apparently no success can be hoped for the attempt to transfer our dogma to the electron. We are very far indeed from having any proof, or, indeed, from having any reason to believe, that electrons are permanent and indestructible. On the contrary, we are compelled to look upon them as essentially transient and evolving manifestations of energy. While the great revelations of the last ten years have cut the feet from under the doctrine of the conservation of matter, they have not affected in any degree the much greater doctrine of the conservation of energy; but, on the contrary, have afforded it additional support. To some aspects of this question we must return in a later section.

Radium. Everyone with a guinea to spare may become the possessor of a tiny speck of the most expensive, rare, and wonderful of all known substances. At the present rate in the rise of the value of radium, however, the makers of the remarkable toy called the *spinthariscope*, which was invented by Sir William Crookes, will soon have to raise its price. This spinthariscope is a little brass tube about an inch and a half long, which is closed at one end and has a couple of magnifying lenses at the other. On the inner surface of the blind end there is a small piece of paper which has been coated with minute crystals of zinc sulphide.

Just in front of this piece of paper there stands out a metal pointer like the hand of a watch. The end of this pointer has been dipped in a solution of a salt of radium. If, now, one takes the spinthariscope into a dark room and holds it close to the eye, one sees a shower of points of light that seem to radiate from a centre and that come from the surface of the zinc sulphide paper. This shower of sparks never ceases, night or day, year in and year out. The present writer mislaid his spinthariscope, and when he found it again after some months and saw this shower of sparks still occurring, and realised that it had never ceased throughout the

intervening period, the most amazing of all the features of radium was at last brought home to him.

Estimated Duration of Radium Energy. Various calculations have been made as to the length of time during which the scanty deposit of a radium salt upon the pointer of a spinthariscope will continue to evolve the energy of which the shower of sparks is the manifestation. The least estimate runs into thousands of years. The flashes of light are believed to be due to the cracking and splintering of the crystals of zinc sulphide by means of something which flies out from the radium and strikes them. Thus, it is probable that the paper may require to be renewed after some time; but that is merely because it will cease to indicate what does not cease—the continual evolution of energy by the radium within the spinthariscope.

Sometimes the owner of a spinthariscope is annoyed to find that the shower of sparks is very inconspicuous. If the toy be slightly warmed, the shower will soon reappear. Whatever the cause of this fact be, it has certainly nothing whatever to do with the behaviour of the radium itself. For radium continues to evolve energy in liquid air or hydrogen at a temperature more than 200 degrees below zero just as well as it does at ordinary temperatures. Indeed, its behaviour seems to be unaffected by anything that we can do to it.

The New Alchemy. Now, the sight which the spinthariscope affords is really the vindication of the much-abused alchemists, who sought to turn the baser metals into gold. Later generations laughed at them and said: "Oh, no, you cannot transmute one element into another, for each element has its own kind of atom; and the atoms are the unalterable foundation-stones of the universe. They cannot be changed into one another, and so you cannot change lead into gold. Your philosopher's stone is a myth." But this supposed impossible thing is precisely what is happening in the spinthariscope. Let us consider the facts.

Radium is certainly an element—as much an element as gold or lead or any other; and, of course, it has a characteristic atomic weight of its own. This has been variously estimated during the last year or two, Madame Curie, the discoverer of radium, estimating it to be 225; while other observers, using other methods, estimated the figure to be 256. This last would constitute radium the heaviest of all known substances. Madame Curie, however, has been proved to be right, and radium is recognised as the third heaviest of known substances, the heaviest being uranium, with an atomic weight of 240, and the next thorium, with an atomic weight of 232. The fact that the atomic weight of uranium is greater than that of radium is extremely important, as we shall see when we come to discuss the evolution of radium.

The Emanation of Radium. Now, if some of this element be confined in a tube, we find, after a time, that there appears in the tube a minute quantity of a gas or *emanation* which was not there before. This is not gaseous radium, for when it is examined with the spectroscope it shows a spectrum quite different from that of radium; in fact, its spectrum is quite different from that of any known substance. But it was discovered by Sir William Ramsay that if the spectrum of this mysterious emanation be examined again after an interval of about four weeks, it is found to have changed into a familiar spectrum which is instantly recognisable as that of the rare element known as *helium*. The astonishing fact, then, is that the element radium decomposes itself and produces another element, helium. Now, the atomic weight of helium exactly corresponds to the weight of the tiny particles which are now known to be shot out from radium, constituting what are called the *Alpha* rays. These particles, flung out from the radium upon the pointer of the spinthariscope at an incredible speed of tens of thousands of miles per second, bombard the zinc sulphide paper and so produce the shower of sparks to which we have referred.

Radium and Universal Evolution. In the history of the science of radio-activity, this great discovery of Sir William Ramsay's takes a prior place, since it proves once and for all that the doctrine of universal evolution is applicable to atoms. Herbert Spencer's original definition of evolution, framed more than forty years before the discovery of radium, is applicable to the facts discovered yesterday as if it had been framed in order to describe them. Thus the most important fact about radium for the philosopher, the physicist, and the chemist alike, is that it proves the truth of atomic evolution. Not even an atom is immune from the universal law of unceasing change, and thus every spinthariscope is a lasting refutation of that memorable phrase of Clerk-Maxwell's to which we have so frequently referred. Furthermore, radium has proved that Sir John Herschel and Clerk-Maxwell were wrong when they declared that the atom bears upon itself the "stamp of the manufactured article." Atoms are not manufactured, but have evolved and are evolving.

The Evolution of Radium. Of all the elements, the last that radium suggests to the mind is lead, unless, indeed, the suggestion were by contrast. Lead has long stood as the symbol for all that is mean and worthless and dull and unremarkable; whilst we know radium to be the most brilliant, the most valuable, and incomparably the most remarkable of all the elements. Lead stands for something worse than mediocrity, radium stands for uniqueness and genius. But in recent months it has actually been discovered that lead—almost certainly—has its place in that evolutionary chain of which radium is the most remarkable link.

But before we ask what becomes of the atom of radium, let us inquire into its own origin. We know that there is extremely little radium in the world, and we find that what radium there is is constantly being decomposed into simpler elements. Indeed, we can barely understand the facts unless we assume that, while radium is itself being decomposed, it is, on the other hand,

being produced in some way or other—the amount of radium actually existent at any one time being determined by the comparative rates of these two processes. We now, indeed, have every reason to believe that radium itself is the child of uranium—wherein lies the importance of the fact, upon which we have insisted, that the atomic weight of uranium is greater than that of radium. These two elements are associated with one another wherever they are found; and not only so, they are associated in a constant ratio. This ratio is determined entirely by the relative life periods of the uranium and the radium atom.

Radium and Lead. As we have already seen, the so-called *Alpha* rays of radium are now known to consist of material particles, each of which must be regarded as an atom of helium in a state of great excitement and activity. Now it is obvious that the radium atom cannot continue to lose an indefinite number of these immature atoms of helium without itself undergoing certain changes. In fact, the radium atom is changed. When it has lost one atom of helium it is no longer a radium atom, but the atom of another element. It is now believed that each radium atom is capable of losing in succession five atoms of helium. At each stage it is a different and definite product and must receive a different and definite name. (These names have not yet been quite agreed upon, but the reader may have heard of actinium and polonium, the latter having been named by Madame Curie after her native country. It is now seen that these names must apply to various stages in the transmutation of the atom of radium.) And now we come upon the extraordinary conclusion, apparently beyond all dispute, that when five such helium atoms have left what was originally an atom of radium the atom left behind is none other than an atom of lead. Such is the ignoble end of a brilliant career.

Origin of Radium. It is obviously not correct, however, to use the phrase, "originally an atom of radium," for we know that the radium atom, large, heavy, and complicated though it be, is yet none other than a decomposition product of a heavier, larger, and still more complicated atom—that of uranium. What are we to say of this? Is the uranium atom also only a temporary product of an element consisting of atoms yet heavier and more complex than its own? This, indeed, seems highly probable, though no such element is known. But it is not easy to see where we are to stop in the speculations which these new discoveries have suggested. Though uranium has the heaviest atom we know, there is no conceivable reason why it should be the heaviest atom possible. Indeed, it has been suggested that we must go back in thought by successive stages to a period when the whole universe was one atom.

Yet if we have difficulties in this direction, we have difficulties no less in the other direction. The atom of lead is extremely heavy and complex. Why should it be the last stage in the process which "began" with uranium. No one, indeed, now thinks that it is the last stage, and by some it is thought that the element silver, which is so constantly found in association with lead, may represent the next most striking stage in this particular sequence of atomic evolution. But in this direction also, where does the process stop? Are we to suppose that the universe began as one huge atom, and that its last stage will be represented by the breaking down of all atoms into what we now believe to be the common constituent of them all, the electron, or corpuscle, of negative electricity?

Helium. However these things may be, we must at any rate study, so far as is possible, the remarkable element helium, which is so positively known to be a product of the decomposition of radium. When the spectrum of the protuberances of the sun was first studied, it was found to indicate the existence of an element with which chemists had no acquaintance. But it was subsequently discovered by Sir William Ramsay that this same element is present in a rare Norwegian mineral which has the name of clevite; the element is now known as helium (from Greek *helios*, the sun). Thirty years elapsed between the discovery of helium in the sun by the late Sir Edward Frankland and Sir Norman Lockyer in 1868 and Sir William Ramsay's demonstration of the existence of this element upon the earth. This is the one substance which Sir James Dewar has been unable to liquefy. He writes: "It has been expanded from a pressure of 80 to 100 atmospheres at the temperature of solid hydrogen without the least indication of liquefaction being perceived, although in this connection it must be remembered that its exceedingly low refractivity would render small drops of the liquid forming in the gas near its critical point very difficult to see. It may, however, be said without much doubt that helium has been cooled to 9 or 10 degrees absolute (264 or 263 degrees below zero centigrade) without sign of liquefaction, and the inference is that its critical point is below 9 degrees absolute. This means that its boiling point is about 5 degrees absolute, or one-fourth that of liquid hydrogen."

Continued

Group 22
TYPEWRITING
3

Continued from page 1888

TYPEWRITING AS A BUSINESS

The Office and its Equipment. Staff. The Prices Charged for Work. Departments and Suggestions for Enterprise

By W. B. ROBERTSON

As a means of livelihood typewriting, usually in conjunction with stenography, is becoming almost the exclusive sphere of women. It is work for which they are particularly fitted. It demands precision, neatness, and attention to detail which seem to constitute too great a strain on the average masculine capacity. When women enter a field in force the position of man becomes gradually untenable, as it seems to be an accepted, though unjust, dictum in our commercial economy that a woman, although fitted for and doing the same work as a man, ought to be content with a very much smaller remuneration. The advent of women into the domain of commercial office work was synchronous with the introduction of the typewriting machine, and women took to the work with the facility of the duckling entering the farm pond.

Conditions of Employment. The conditions of employment of the lady stenographer and typist are almost as diverse as the offices where she is employed are numerous. The occupation is considered mechanical, and all purely mechanical employments are poorly paid. But a good general education, and the ability to exercise independent judgment in case of ambiguity in the copy, is essential in a thoroughly trustworthy typist, so that the popular conception that typewriting is easy and merely mechanical is erroneous. We have heard of girls who professed expert ability both as shorthand writers and as typists accepting positions at 6s. per week. There are certainly some thousands in the City of London to-day who are earning between 12s. and 16s. a week. But if the average wage of a good typist in a good office could be estimated it would probably be found to be from 25s. to 30s. a week. To attain a higher figure a woman must have exceptional ability and a knowledge of foreign languages, apart from mere proficiency in shorthand and machine manipulation. The typist aspires to the dignity of proprietress-ship of a typewriting office. The starting of such an office is an important step, and demands caution and circumspection.

This is a specimen of the Small Roman type.

This is a specimen of the Script type.

This is a specimen of the Medium Roman type.

This is a specimen of the Italic type.

This is a specimen of the Large Roman type.

This is a specimen of the Gothic Italic type.

THIS IS A SPECIMEN OF THE GOTHIC CAPS & SMALL CAPS.

THIS IS A SPECIMEN OF THE ATTIC TYPE.

This is a specimen of the Gothic type.

SPECIMENS OF TYPE—TWO-THIRDS ACTUAL SIZE

A Typewriting Office. The typist ought to have some assured regularity of work, or should be in an exceptionally favourable position for securing it, before she takes an office. Rent and other expenses must be paid whether work comes in or not. The choice of an office is the first consideration. If she have guarantee of regular employment she will naturally instal herself in a position as convenient as possible to the offices or residences of her prospective customers. The large office buildings which in London and other large centres form hives of commercial and professional activity offer the best places for such an establishment. Proximity to possible customers is an essential to constant custom, for the best patrons may be wooed away by an opposition office if the latter be nearer and therefore more convenient.

The beginner should not consider an office at a higher rent than £50 a year. Indeed, she ought to get one for much less, say £30 to £40, which will be centrally situated and give all the necessary accommodation of two or three rooms. Also, she should not saddle herself with a lease of the office. It is usually possible to secure the premises upon month to month terms.

Equipment. The office, having been secured, must be equipped. The most expensive items are the typewriters themselves. The cash price of the best makes is £22 each. It is possible to buy cheaper machines, but the opinion of the majority of those who make their living by manipulating a typewriter is that, excellent as the cheaper machines may be for occasional and private use, they are not sufficiently strong and reliable to stand the hard wear of constant thumping for eight hours a day throughout 300 days in the year. But the total disbursement need not be made in one payment. All the typewriter companies are prepared to sell their machines upon the hire-purchase system, and the extra price demanded for the accommodation is only 5 per cent. The usual terms of payment on the instalment system of purchase are £2 deposit and £2 per month.

Second-hand Machines. A word may be said about second-hand typewriters. Occasionally these are more expensive than new machines owing to the imperfect state of repair. The lady who buys a second-hand typewriter is usually wise to patronise one of the typewriter manufacturing firms, or, if she buy it from an outside dealer, to have it examined and certified to be in thoroughly good order by the makers.

It is not our purpose to discriminate between the respective merits of the many typewriters put forward as the best on the market. The purchaser must decide this point from an inspection of the machines themselves or from perusal of descriptive literature, which every manufacturer is only too pleased to supply. But it is a point worthy of note by anyone purchasing a typewriter for use upon many different classes of work that machines of the type of which the Hammond is the best known afford the facility of changing from one style of lettering to another by the mere withdrawal of one type shuttle and the insertion of another, an operation of only a few seconds.

The accompanying illustration shows a representative variety of type, reduced to two-thirds actual size. With any make of typewriter the purchaser may have the design of type preferred. The particular styles shown are from the Hammond machine.

Office Furniture. Besides the typewriter each operator must be provided with a desk and a chair, the joint cost of which need not exceed 50s. A smaller sum may be made to suffice by purchasing only a couple of small tables and a few chairs, which may always be bought very cheaply second-hand. Other items of capital expenditure are a carpet or other floor covering, a stock of paper to the value of, say, 20s., some carbon duplicating paper, say, 12s., and the office stationery necessary in any business. The duplicating department, which should be pushed, will entail the purchase of apparatus. Undoubtedly the Roneo or Rotary Neostyle is the best machine for such work, but its cost is high—from £10 10s. to £17 17s., and the beginner will be satisfied with a machine like the mimeograph which, with accessories, costs £2. The office must be provided with a good dictionary, but one may be purchased for 2s. 6d. If it be found that technical or scientific work comes in regularly and in fair quantity, a technical or scientific dictionary may be required. It is essential to have books of reference to check uncertain orthography. Then, if translation and copying in foreign languages be a department, a set of English-foreign dictionaries must be bought.

Staff. The woman who opens a typewriting bureau will, unless she be fortunate enough to begin with a very good list of regular customers, find that two assistant operators are capable of overtaking all the work she is likely to secure. At least one must be a capable stenographer, as demands will occasionally be made for one to be sent out to write at someone's dictation.

Young girls are often taken into typewriting offices as learners, and the practice enables the proprietress to secure service without salary expense and in return for tuition. Indeed, it is common for learners to pay a premium of £5 5s. to £10 10s., but it is somewhat difficult for a novice in proprietorship to secure premium pupils. An intelligent learner should in six months acquire expertness in the operation of a typewriter and moderate speed in shorthand, thereby becoming entitled to a salary. She should at the same time have attained a good knowledge of secretarial and general office work. During the first two months of her tuition she will, however, prove of little practical value in regular typewriting work, where experience is essential, and it is uneconomical to trust too much to such assistance.

Copying. The copying of manuscript is usually the chief business of the office, and is the least remunerative class of work undertaken. Even at the prices given in the table which follows the profits are not large if fair wages be paid to the typists employed. Some expert operators can turn out 1,000 words an hour, but this speed can never be maintained for an entire working day. The average amount of work for an eight hours' day is from 4,000 to 5,000 words, according to the clearness of the copy and its nature. If an operator cannot do this quantity she is not entitled to claim to be a fully-qualified typist.

Mimeography. The manifolding of circulars by the aid of a mimeograph or other manifold machine is far more remunerative than ordinary copying work. An operator can easily take off 200 to 300 copies an hour after the stencil sheet has been typed, and at the prices given in the list this pays very well indeed. This department should be pushed on every possible occasion, and by impressing the advantages of mimeographed circulars upon customers, much work which would otherwise issue in printer's type may be secured for the typewriting office.

Translation. It is desirable and frequent that translations to and from French and German should be executed in the office either by the principal or by a qualified assistant. It is, however, unusual to translate other foreign languages in the office, but to send them to regular translation bureaux. Many typewriting offices whose proprietors profess to do such work in the office merely send it to a translation bureau. The usual practice is that the translation bureau allows a discount of 25 per cent. from usual retail price, and this proportion represents the profit of the typewriting office.

Shorthand Work. The shorthand department of a typewriting office is another fairly lucrative branch, if prices recognised as standard and given on next page, be maintained. The work is paid for by time, and the quantity possible in a given time depends upon the speed of the dictator rather than upon the ability of the stenographer. The assistant sent to record dictation should always be able to work up to the limit of the customer's speed of speaking, for nothing dissatisfies the latter more than a stenographer for whom he has to wait. [See SHORTHAND.]

Prices. The usual charges for the various classes of work undertaken in good offices are on the following scale:

TYPEWRITING AND SHORTHAND.

Legal and Scientific Documents, Specifications, and General Copying	1½d. per folio (72 words).
Carbon Copies	Half-price top copy.
" " of Brief and Draft Work	1d. per folio.
Balance Sheets and Tabular Work	2d. per folio.
Authors' MS. in quantities of 5,000 words and over ..	1s. 3d. per 1,000 words.
Authors' MS. in quantities of over 10,000 words	1s. per 1,000 words.
Plays	5s. per Act of 18 Typewritten 4to pages.
" after 18 pp.	3d. per page.
Actors' Parts	2d. "
Typing from Foreign Languages .. .. .. from	3d. per folio.
Hire of Machine with Typist	2s. 6d. per hour, 10s. 6d. per day, £2 per week.
Hire of Machine with Shorthand Writer and Typist ..	3s. 6d. per hour, 12s. 6d. per day, £3 per week.

(Hours 10 a.m. to 6 p.m.; overtime by arrangement; cab fare extra).

Typing from Dictation in Private Room on the premises	2s. 6d. per hour.
Shorthand Writer on the premises	2s. 6d. "
Typed Transcript of Shorthand Notes .. .. from	3d. per folio.
Addressing Envelopes and Wrappers	From 7s. 6d. per 1,000.

MIMEOGRAPHY.

For reproducing Typewritten copies of Letters, Circulars, Specifications, Balance Sheets, etc., etc., 10–1,000 copies from one Stencil.

No. of Copies.	Note. £	s.	d.	Quarto. £	s.	d.	Foolscap. £	s.	d.
10	0	1	9	0	2	0	0	2	6
15	0	1	9	0	2	0	0	2	6
20	0	2	0	0	2	3	0	2	9
30	0	2	3	0	2	6	0	3	6
40	0	2	6	0	3	0	0	4	0
50	0	3	0	0	3	6	0	4	9
75	0	3	9	0	4	6	0	5	9
100	0	4	6	0	5	0	0	6	0
200	0	8	0	0	9	0	0	11	0
300	0	12	0	0	13	6	0	16	6
400	0	15	0	0	16	6	0	19	0
500	0	19	0	1	0	0	1	4	0

Typing of Stencil, 6d. per page.

TRANSLATIONS.

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It must not be assumed that these charges are general. They are often cut mercilessly by those eager for business. We have seen quotations for copying work at 8d. and even 6d. per 1,000 words. Usually, the quality of the work bears a direct relation to the prices charged, and the office that seeks work at any price develops into a sweating den of the worst type.

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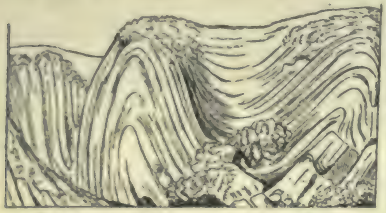
The man who dictates into a machine must have either an Edison commercial phonograph, which costs £15, plus 12s. 6d. extra for a recorder, or a Columbia commerical graphophone, which may be bought for £10. With the former machine, an apparatus for shaving the cylinders is provided, but with the latter £5 extra must be paid for a shaving machine, so that the costs of the respective outfits are practically equal. It may be noted, however, that, with the graphophone separate outfit, the recording cylinders may be more effectively cleaned than with the alternate apparatus. Recording cylinders cost 1s. 6d., and take about 700 words each. They may be shaved and re-used some 40 times. For office use two machines are necessary—one for the dictator, and one for the typist, as either machine is too weighty to be transported conveniently. The typewriting bureau, where the necessary machine is kept, is open to overtake the typing of matter recorded upon the wax impressions, and it seems certain that there will be an increase in the demand for such service in the near future.

Business Methods. Little remains to be said about the methods of business. Neat circulars, intimating the opening of an office, and indicating the scope of the work undertaken, ought, of course, to be issued to likely customers. If the office be in a large office building, good may be done by making regular morning calls upon every individual or firm likely to have work. The worst that can happen is a refusal, polite or the reverse, according to the breeding of the individual addressed. Accounts should be rendered whenever any work is done, or, if to regular customers, weekly. Work is often secured by advertising in literary papers. Authors' work is usually desirable, being straightforward and very often in good batches.

Typewriting concluded

Succession of Strata. The student may familiarise himself with this statement by taking a number of different coloured papers or pieces of cloth, and laying them on the top of one another. If this packet be laid flat, it will represent the mode and position in which the various strata were laid down on the bed of the ancient sea. Each bed or layer of rock is distinct from the one beneath it, although they may all be composed of similar materials. We may, for instance, have a series of layers of sandstone, or an alternation of sandstone with shale, or an intermingling of organic strata such as coal seams, or a still more complicated mixture of strata.



74. CRUMPLING OF STRATA (Lyell)

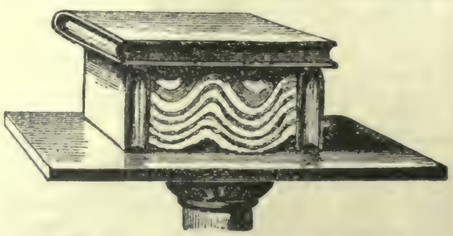
Each bed or stratum corresponds to a definite portion of time in the development of geological history, during which a certain kind of debris or loose material was being laid dawn, afterwards to be consolidated into comparatively hard rock. While the strata remain in their original position, only the one on the top, which, of course, was the last to be laid down, is visible. It is only by boring through the mass, as in sinking a well or coal pit, or in making a railway cutting, or when a natural section is made by a river cutting its gorge, or the sea undermining a cliff, that we learn the nature of the underlying strata. But it is evident that if we take our packet of sheets of paper and turn it on end, an observer looking from above will at once see the whole series of strata exhibited to his view. The same will be the case if, instead of turning the packet on end, we lay it on a sloping desk and, with a sharp knife, cut a horizontal section through it. On the flat surface thus produced the various sheets of paper, representing our typical strata of sedimentary rock, are exposed in the same order as that in which a vertical shaft would pass through them. This is what has actually happened in nature, and simplifies the task of the geologist.

The Strata Tilted. If it were not for the fact that the strata had thus been tilted in most parts of the earth, we should be confined for our knowledge of the earth's crust to such shallow scratches and borings as man is able to make. At the utmost we should know the nature of the crust to the depth of about a mile. But the fact that the strata have been tilted provides us with a far greater range of knowledge. For the denuding agencies which are ever at work on the earth's surface have done for the actual strata precisely what we have done with a sharp knife to our imaginary model. The contours or wrinkles on the earth's crust, which we saw to be a necessary consequence of the earth's cooling and contraction, have tilted the strata to very considerable angles [74]. We can see how this happens if we take a thickish paper-bound volume—a Christmas number of a magazine will do nicely—and, laying it flat on a table, press its edges towards one another. The result is that the middle of the book is elevated, whilst the separate leaves, which represent the strata of the crust, are thrown into a curved form [75], which, of course, means that they are tilted out of the horizontal into an arch.

Mountain Modelling. In this way the vast mountain range or tableland is formed—a wrinkle or swelling on the earth due to the contraction of the interior. The denuding agencies promptly get to work on this elevated region and gradually wear it down. If they were allowed to go on for an indefinite term, they would wear the whole surface down to the sea-level. But as even geological time is not infinite, these forces have succeeded only in wearing so much of the elevated part away as to leave what we now call a mountain range—such as the Alps—which is chiselled into the most wild and picturesque irregularities of shape simply because its materials were not homogeneous but of varying degrees of hardness, and consequently one part has been worn away faster than another.

The details of mountain carving are outside the necessarily limited scope of this course, but they may be studied with the greatest interest in more elaborate textbooks, such as Sir Archibald Geikie's "Scenery of Scotland." We need simply point out that the history of all mountainous districts is one of general elevation of the surface followed by the long secular process of modelling due to the various denuding agencies. It may be compared to the work of children making a snowman, who first heap up a roughly spherical accumulation of snow, and then shape it by scraping away the unnecessary parts.

Remnants of Ancient Mountains. Thus, our present mountain-chains, imposing as they are, do but represent the worn and wasted remnants of the huge elevations of earlier times.



75. CRUMPLING OF STRATA (Lyell)

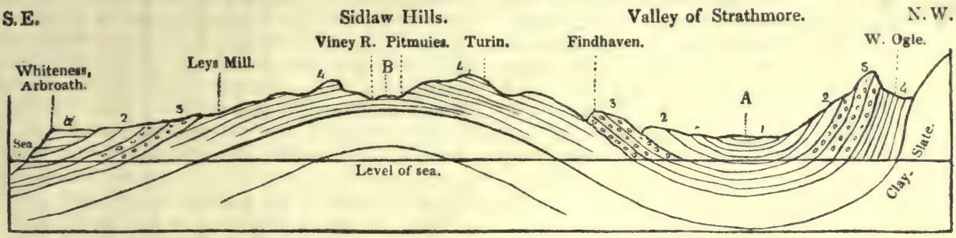
This process has occurred not once but scores of times in the history of the earth, and the present configuration of its surface is only the last term in a vast series. Again and again vast regions have been elevated and carved away by the denuding agencies till they fell so low that the sea overflowed them. Again they were elevated high above the sea-level, and again carved down, and this process has in some instances

been repeated to our actual knowledge five or six times at least.

The "Everlasting" Hills. We may infer that this movement has taken place far oftener. If we think of the slow changes which now occur among the "everlasting hills," which are practically the same to-day as they were when Homer sang and Rome was represented by only a few poor huts, we shall get some notion of the vast and almost unimaginable ages which have elapsed since the earth cooled down sufficiently to develop the seas and watercourses which have been the chief agents in this work. Yet it is probable that even this incalculable space of time is but the smaller part of the æons which have passed away since the whole solar system existed in the condition of a fiery nebula. That nebula itself may, according to a very probable hypothesis, have been the product of an earlier collision between two stars, each of which may have had its attendant planets as far advanced in the order of evolution as the earth is now. Science is impotent to do more than adumbrate such a possibility as this, the serious contemplation of which overwhelms the mind with the sense of its own insignificance.

expect to be the case, since we know that they were originally laid down on a roughly horizontal sea-bed. Sometimes, however, instead of being regularly tilted they have been crumpled into all kinds of bewildering curves, in which case they are spoken of as being *contorted* [**74**].

Arches and Troughs. The most common way in which strata have been tilted is that illustrated by the experiment with a magazine described above, where pressure from either end of the strata has raised them into a wide arch. In that case the strata at the two ends of the arch will be found to slope in opposite directions [**76**], while as we travel from one end of the arch or dome to the centre, we find that the dip of the strata is steadily diminishing, until at the centre it is reduced to zero and the strata there are horizontal. If we go further on the dip is reversed in direction and steadily increases. The surface of the ground in many places has been changed by the pressure consequent on the earth's internal contraction into a series of *arches*, which must clearly be divided by corresponding *troughs*, very much like the surface of the sea. In a trough it is clear that the changes in the dip of the strata



76. TROUGHS AND ARCHES OF STRATIFICATION

Dip of Strata. The past history of the earth, so far as geology can read it, is written in the strata of the sedimentary rocks. We can study these at our convenience, owing to the already explained fact that in most cases they have been tilted so that their ends, chiselled off by the sub-aerial denuding agencies, reach the surface, where we can study them at our leisure. These outcrops form, as it were, pages in the great book of the geological record. They are numbered consecutively, so that we know the order in which to study them, the upper ones being the later.

When we find a stratum or bed cropping out on the surface, the first thing that we have to do after finding out of what kind of rock it is composed is to see what angle it makes with the horizontal. This angle is called the *dip* of the strata, and it is measured by a simple instrument known as the *clinometer* [see page 803], which consists of a graduated semicircle with a pendulum pivoted on its centre. Whenever we are able, as in a railway cutting or a quarry, to see the strata in section, we can measure their dip by holding the diameter of our semicircle parallel to a bedding plane, and noting at what division on the scale the pendulum then hangs. As a rule the angle which the beds thus form with the horizontal is fairly constant, as we should

will be just the opposite to those in an arch. When the strata dip away from a central axis so as to form an arch, the structure is called an *anticline;* when they dip towards the central line so as to form a trough it is called a *syncline.*

Broken Arches. We seldom find this complete structure now in existence, since the arch has usually been worn away and the trough has been filled up by the processes of denudation and reconstruction which are always going forward. But we can reconstruct it in imagination by studying the dip of the strata. Where at two points some distance apart we find beds of a similar rock cropping out on the surface of the ground, pointing upwards and towards one another, we see without hesitation that they once met each other in a vast dome or saddle; if the dip of the strata be downward and each side towards the other, we infer that they actually meet at a point far below the surface. This curved arrangement of the strata characterises the greater part of superficial sedimentary rocks. In many places the curvature is more complicated and irregular; the strata have been so contorted, as in many parts of the Alps, that they are actually *inverted*, or bent round so that one part of the same stratum lies vertically upon another. But all these more complicated

forms of curvature are due to the same cause, the bending of the originally horizontal strata under lateral pressure.

Outcrop and Strike. The part of a tilted stratum which emerges at the present surface of the ground is called its *outcrop.* Where the stratum is of considerable width, this outcrop forms a long streak, the direction of which is known as the *strike.* The strike is obviously at right angles to the direction of dip. The width of the outcrop depends upon the thickness of the stratum and its inclination to the horizontal, since the outcrop is a section cut through the stratum by a horizontal plane. It may be only a few inches in width, or it may be many hundreds of feet. In the latter case it is usually found that the stratum, though composed of the same rock throughout, is divided by a number of fissure planes into a series of thinner strata, or *laminæ,* each of which corresponds to a definite period of the time when the materials of the rocks were being deposited.

The Order of the Strata. One of the most important things to study in connection with the sedimentary strata is the order in which they were deposited. In the rare cases where the strata still preserve their original horizontal attitude, the lowest stratum must clearly be the oldest, and the uppermost one the most recently deposited. If the strata have been tilted or crumpled [**77**] they still preserve the same relative chronological order. In order to find out from a series of strata cropping out on the surface of the earth which was originally the lowest, we have simply to measure the direction of their dip. Obviously, the stratum which has its outcrop farthest in that direction was originally the uppermost and is, therefore, the youngest. As we walk in the opposite direction we are tracing the strata backwards in time.

In this way we are enabled to say with entire certainty what was the order in which certain sedimentary rocks found in juxtaposition to one another were laid down ; and geologists have been able to establish a definite and coherent history of the earth, which it will be our business to describe in the concluding section of this course. We have already seen that the great majority of the sedimentary rocks contain fossils. These remains of prehistoric creatures differ widely in character and species, according to the rocks in which they are found. This fact has been of the greatest service to the study of the evolution of life, since the geologist is able to tell the biologist that certain rocks have invariably been laid down after certain others, and, consequently, that the fossils found in the latter were the ancestors, or at least the forerunners, of those associated with the former.

Geological Time. There is, unfortunately, no absolutely certain method of translating the geological scheme of time into the terms of human chronology. We can say with entire certainty that one stratum or set of rocks has been laid down before another, but we can only make rough guesses at the actual lapse of time which separates these events. Some inference may be drawn from the rate at which we see certain kinds of rock, such as shale or sandstone, being laid down at the present day. But it is very dangerous to argue that the same rate existed in the remote past. What we can be sure of is that the lapse of time represented by the formation of the sedimentary rocks was very great. To take a single instance, the carboniferous limestones of Western Europe are composed entirely of the shells and skeletons of minute organisms which lived in a long vanished sea, and strewed their calcareous remains on its bed when they died and sank down through the water. This process went on long enough to accumulate thousands of feet of limestone ; and at the very lowest estimate, that must have taken many thousands of years ; yet this is but one layer out of the immense thickness of sedimentary rocks which have been gradually accumulated in the upper part of the earth's crust. The geologist is probably well within the mark when he demands anything from one hundred to five hundred millions of years for the slow unfolding of the earth's physical history.

Joints. The sedimentary rocks are not only characterised by the roughly horizontal divisions into strata, but by vertical fissures or planes of division, which are known as *joints.* These are probably due to the strain which has been brought to bear upon these rocks in the course of the shrinkage of the earth's crust. Experiment has shown that the folding or twisting of the rocks gives rise to joints, just as the strain put on the ice of a glacier by its movement makes it crack into numerous crevasses. Igneous rocks present a jointed structure as well as stratified rocks, in consequence of the same cause. The existence of these joints has a two-fold importance to man. In the first place, they provide channels for the circulation of underground water, which travels along these cracks in an otherwise impermeable rock, and thus is enabled to contribute to those widespread subterranean effects which have already been described, and also to return to the surface in the form of springs where the configuration of the ground permits of this. It is also by taking advantage of these joints that the miner and the quarryman are enabled to perform their work with a minimum of exertion.

77. TILTED STRATA

Division Planes. Stratified rocks, like flagstone and sandstone, are divided into more or less rectangular blocks by the double set of division planes which intersect them—the bedding planes which divide strata horizontally, and the joints which are usually vertical. In this way large cubical blocks can be quarried without much difficulty by taking advantage of these natural divisions. An ordinary block of household coal illustrates both sets of planes very well. It is divided in

one direction into comparatively fine laminæ, which have usually soft surfaces and soil the fingers ; these are bedding planes, or planes of stratification, which were originally horizontal or parallel to the dip of the coal seam. At right angles to them will be found joints, along which the coal splits when struck with a poker ; the face thus exposed is rough and bright, and does not soil the fingers. Good coal will usually split along these two faces into roughly cubical fragments. The picturesque cracks and castellated structure so often seen in sandstone and limestone districts are due to the splitting of the rocks by meteorological action along the lines of joints. Igneous rocks are traversed by one set of divisional planes only, the joints. Thus, the quarrying of a rock like granite is attended with greater difficulties than that of the stratified rock, as it naturally tends to split only in one direction. The remarkable columnar structure of basalt as seen by tourists in the Giant's Causeway [see page 1008] and the Caves of Staffa are due to jointing.

Cleavage Planes. *Cleavage planes,* which we have already described as occurring in minerals, are a third set of divisional planes which have been induced by severe and long-continued pressure in certain rocks. It is most perfectly seen in slates [see page 1355], which can be readily split into thin plates along the cleavage planes. Some igneous rocks like the felsites show well-marked cleavage planes, which enable them to be readily split up into flags for paving.

There is another kind of division in rocks which has been caused by movements of the crust. This is known as a *dislocation,* which is simply a fracture extending for some distance through a mass of rock. Where the dislocation consists of a simple crack in the rock it is known as a *fissure.* But in the majority of cases the fracture has been accompanied by a vertical displacement of the rocks on one side of it, and it is then known as a *fault* [see page 1352]. Where the fault occurs in stratified rocks, the strata on one side of it no longer conform to those on the other. They have been moved bodily up or down, and the result is that they no longer join on to one another.

"Faults" and Earthquakes. Faults of this kind usually lead to weakening of the crust where they occur, and often play an important part in the occurrence of earthquakes or volcanic action. The reason why the district of Comrie is peculiarly subjected to earthquakes is that it lies upon the great fault of Perthshire. Faults are very important to miners, because where one occurs the coal seam or vein of metallic ore seems to come to a sudden end. As a matter of fact, it has been shifted bodily up or down, and some geological knowledge is necessary in order that the miner may know where to look for its continuance. A fault may be a vertical dislocation, but it is usually inclined. Its inclination from the vertical is known as the *hade,* and the amount of vertical displacement of the strata on either side is known as the *throw.* In the case of the vertical fault there is no lateral displacement of the strata, but if the fault be inclined, it will be seen that the lateral displacement may be very considerable, and its extent depends both on the throw and the hade. The strata on each side of the fault preserve their relative positions, and when the hade and the throw are both known, it is an easy matter to calculate where the continuance of the lost seam or vein may be looked for. For further details the student may be referred to the course on Mining.

Continued

concluded from page 1862

POOR LAW APPOINTMENTS

Positions on the Non-resident and Resident Staffs. Clerks, Relieving, and Medical Officers, Masters, Matrons, Nurses, Attendants, Storekeepers

By ERNEST A. CARR

Clerk to the Guardians. This, the foremost office on the Poor Law staff, may fairly be compared in more than one respect with that of town clerk. Like the latter official, the clerk to the guardians is at once head of the executive and adviser to his authority. In both capacities his duties are very important. It must be remembered that the board of guardians is an association of amateur administrators ; and that while its members are for the most part properly equipped for their tasks, instances of prejudice, misconceived powers, and mistaken zeal are not unknown among them. Naturally, the difficulties arising in the administration of poor relief are, in the main, legal. This work is governed by a complexity of statutes, Local Government Board orders and circulars, official precedents, and decided cases ; and with the risk of surcharges always present, it is a responsible and difficult task to pilot the board in safety through its many functions. To take but a single instance, the question of "settlements"—which consists in determining the parish or union to which a pauper is properly chargeable—presents some of the knottiest problems that ever gladdened the heart of a lawyer.

The Need for a Legal Training. Hence it is that some sort of specialised legal training, whether professional or not, is almost as indispensable for the position of clerk to the guardians as a wide experience of Poor Law methods and practice. We may rank as next in importance a thorough knowledge of rating and assessment work. During recent years there has been a growing tendency on the part of the authorities to select for their leading official a solicitor or barrister who is well versed in each of the above requirements, but the proportion of professional men in the service of the guardians is still small. The appointment lately made by the York Board serves to illustrate the class of training that is likely to stand a candidate in good stead. The record of the officer selected as clerk included 11 years spent in a solicitor's office and 15 years' valuable experience in the assessment of property and the details of rating, acquired in the double capacity of assessor of income and assistant overseer.

The Best Training School. A census of guardians' clerks throughout the country would demonstrate that the majority of them qualified for their positions by years of service under the guardians in the capacity of assistant clerk. The best school for candidates is to be found in the office of a clerk to the guardians of a busy area who is himself a solicitor. A stern critic of our Poor Law service has complained that "the system of hereditary succession often prevails in it, as in the case of French executioners under the old régime." Local influence certainly counts for a good deal sometimes in the contest for a chief, although exerted in the direction of official rather than hereditary succession. But the Poor Law service is not the only one in which the reversion of the leading rôle oftenest falls to the understudy.

Salaries and Emoluments. As is inevitable among authorities of such widely differing importance, the remuneration of clerks to the guardians varies greatly. In a small rural union the salary is usually fixed at a figure between £180 and £300 a year. On the other hand, in a busy city or a metropolitan union it may be anywhere within the limits of £400 and £1,000. The clerk to a northern London board, for instance, has received first £500, then £650, and afterwards £850 a year. Those amounts, however, covered the salaries of any assistants employed by him. In this respect there is a good deal of diversity of practice, some guardians paying an inclusive salary, out of which the expenses of an office and staff have to be defrayed, others providing office accommodation or clerical assistance only, and yet others fixing a strictly personal remuneration.

The actual salary attached to a clerkship as such seldom represents the full fruits of the position. The clerk of the guardians very frequently holds several minor appointments in addition, the rewards from which add considerably to his income as clerk, and may even double it. Thus, in the London union already referred to, the total emoluments enjoyed by the clerk as an officer of the guardians are as follow :

	£
Clerk to guardians	850
Clerk to assessment committee (average)	400
Superintendent registrar..	350
Returning officer at elections (average)	25
	£1,625

The first two items include the salaries of assistants.

Similarly, the clerk to a small provincial union at £200 a year receives approximately an equal amount as superintendent registrar of births, etc., £35 a year for his services under the assessment committee, and, in addition (being under no restrictions as to other work), is clerk to the local district council at a salary of £255—a total income of nearly £700 a year. It will be evident, therefore, that the office of guardians' clerk is often a very lucrative one.

Assistant Clerks. The staff of subordinate clerks is small. It ranges from a junior at £40 or £50 a year up to the first assistant clerk,

whose pay may reach £350, but is more often between £150 and £275. The number of intermediate posts is naturally determined by the importance of the union. Concerning the prospects of senior assistants there is nothing to add to what has been said in discussing principal appointments. Their practical training should have special reference to Poor Law accounts and the law of settlement and removal, and can be gained only in a guardians' office.

The Relieving Officer. "The pivot of a well-administered Poor Law," says a distinguished authority, "is an intelligent, sympathetic, and high-minded relieving officer." Without undervaluing the services of the indoor staff, most persons who are in touch with the difficult problems of poor relief will be inclined to echo this dictum.

The peculiar importance of this public servant's duties is explained by the fact that he has to investigate the cases of all applicants for relief and to lay before the board or committee a report of their health, circumstances, character, and ability to work. The guardians personally know nothing, as a rule, of the facts concerning these applicants. They rely on their expert to ascertain those facts; and upon his report and advice their action in dealing with each request for aid mainly and necessarily depends. Now, the essence of effective relief is a wise discrimination between the various classes of applicants. The indolent and vicious must be sternly dealt with, the unfortunate aided, the infirm provided with a shelter—always avoiding the extinction of self-reliance and the fostering of a pauper spirit. If, therefore, the relief administered is to prove helpful and not harmful, the relieving officer must be a shrewd, kindly man, neither credulous nor routine-bound, and his reports must be full, impartial and suggestive.

An Official Man-of-all-work. The relieving officer, with or without assistants, is generally placed in charge of a Poor Law district, within which he must reside. His duties, which are regulated by orders of the central authority, are of a very varied character. In addition to the work already mentioned they include the granting of temporary relief in urgent cases, and of provisional orders for the workhouse; placing lunatics under restraint, and transferring to their place of settlement paupers belonging to other unions. He has also to call in the district medical officer and nurse when occasion arises, and to take out-relief to the poor who are too ill or feeble to call at his office for it.

Qualifications. No officially recognised school of instruction for these posts at present exists, and the majority of candidates enter the service without any real knowledge of their work, picking up such information casually and piecemeal after appointment. There are many objections to this method, and it is fortunate that the School of Sociology and Social Economics affords special facilities enabling a would-be officer to learn something of his duties beforehand. It is hoped that the School will soon be authorised to issue certificates of proficiency. In the absence of any such instruction the best training is afforded by a subordinate or assistant position under an able and zealous officer.

Candidates are usually required to be over 25 and under 40 years of age, the upper limit being sometimes reduced to 35. A medical examination is generally compulsory; and as relieving officers hold money of the guardians in trust, a common condition of appointment is that security shall be found in £100.

Rates of Pay. Superintendent positions command from £220 to £250 a year and occasionally £50 more. Apart from these, the range of a relieving officer's earnings lies within the limits of £100 and £200. A post of average value would commence with about £120 a year and advance to £150 or a little more. London salaries, however, are on a slightly higher general level. In the City, for instance, district relieving officers begin at £160 and rise to £200. On the other hand, a good many rural boards are unable to pay more than £80 or £90 a year for relief work; but in such cases the officer's income is usually raised to about £125 at least by other emoluments. These include the appointments of registrar of births and deaths, vaccination officer, and collector to the guardians—all of them being Poor Law posts, and a small stipend being attached to each. Candidates without previous knowledge of relief work must generally be content to enter as assistant relieving officers at £80 or £100 a year, until qualified by experience for a better position.

Other Posts. In busy districts, separate appointments are generally made to the posts of collector and vaccination officer. The collector in such cases usually receives either 10 per cent. of the sums he recovers for the guardians, or a fixed salary of £100 or £120 a year and a commission of five per cent. in addition. Vaccination officers are paid for each case of successful vaccination according to a scale of fees prescribed by the Local Government Board. Under a London board of guardians, such fees may amount to £130 a year or more. Officials of these two grades are frequently allowed to undertake other work during their spare time.

District Medical Officer. In order to make complete our survey of the Poor Law service, it is necessary to refer to the district medical officer, better known among his patients as the "parish doctor." This is a non-resident post, the local practitioner who holds it being required, in return for a fixed salary paid him by the guardians, to furnish the poor of his district with medical treatment and drugs. Extra fees are prescribed by the Local Government Board for certain operations, and there may be special charges made for child-birth cases, and for cod liver oil and other costly medicines supplied. The remuneration paid is never very considerable, varying from a purely nominal sum to £150 or so yearly. But many a struggling young medical man finds his sheet-anchor in the £80 or £100 a year he

receives as parish doctor; and even more flourishing practitioners do not disdain such an addition to their incomes.

Indoor Appointments. Certain emoluments or allowances accompany the salaries paid to all resident officers of the guardians and of similar authorities. As a rule the indoor staff are provided with free rations, furnished or unfurnished apartments, lights and washing. Matrons, nurses, porters, and attendants are also entitled to their uniforms; and in many instances the subordinate officers have the option of an annual allowance of £3 or £4 in lieu of intoxicants. The lodging accommodation provided varies in value with the status of the official. The scale of rations is fixed in each parish or union by the guardians. As an instance (though hardly a favourable one) of this allowance, the following weekly dietary list for the officers of a rural workhouse is of interest:

Bread, 7 lb.
Meat (or fish, if desired), 7 lb.
Butter, loaf sugar and bacon, each 1 lb.
Tea, ½ lb.; or coffee, 1 lb.
Milk, 7 pints.
Cheese, 12 oz.
Jam or marmalade and moist sugar, ½ lb.
Eggs, 4.
Vegetables, rice, flour, currants, raisins, pickles and condiments as required.

The Workhouse Staff. The recognised heads of the workhouse, on their respective sides, are the master and matron. They exercise general supervision and control over officers and paupers alike, and are answerable for the safety of the guardians' property, the due performance by every inmate of his or her daily task, and the proper conduct of the whole institution. Their duties are elaborately laid down by the General Consolidated Order of 1847. In the words of a Poor Law expert, "The management of the workhouse is in the hands of the master and matron, whose duties are set forth in the regulations in the minutest detail, from the daily reading of prayers and saying grace before and after meals to the cooking and distribution of the food, the general inspection of the wards, and the maintenance of order amongst the inmates. The temperature of the water for the baths is even laid down in the rules."

Salaries of Chief Officers. Without further instances of their multifarious duties, it will be readily understood that the master and matron of a workhouse are busy, responsible and often much-harassed officials. Their work requires good organising powers, energy, and discretion, and a sound knowledge of all the complexities of Poor Law administration and accounts. The incomes with which these qualities are rewarded cannot be said to err on the side of extravagance. For the larger unions, the joint earnings of master and matron usually amount to £200 or £250 a year, with emoluments computed at from £70 to £120 extra in all. In smaller institutions the total income, excluding allowances, varies between £175 and £80, or even less. "Low-water mark" is probably represented by two recent advertisements, both offering, in return for the responsible services of a master and matron, a joint income of £50 a year! The following are more typical examples, the salary of each officer being given separately in every case:

	Master.	Matron.
Liverpool ..	£150	£50
Woolwich ..	£100 (rising to £130)	£60 (rising to £70)
Ipswich ..	£115	£55
Ormskirk ..	£100	£60
Halifax ..	£85	£50
Sevenoaks ..	£75	£50
Slough ..	£70	£40
Salisbury ..	£70	£35
Stockdale ..	£70	£30
Hertford ..	£73	£20
Smallburgh ..	£50	£30

Previous experience of Poor Law work in some capacity is practically essential for these positions. Hence, they are generally filled by the selection of an assistant master and matron, a relieving officer and his wife, or the superintendent and matron of a casual ward. In more than one recent instance a married couple beginning their Poor Law service as porter and portress have ultimately attained control of an important workhouse. As a rule, the master and matron are chosen from among applicants between 30 and 45 or 50 years of age, and either childless or with only a small family.

Subordinate Officers. Assistant masters and masters' clerks are employed only in the larger institutions. A knowledge of the system of bookkeeping and accounts approved by the Local Government Board is a useful qualification for these offices, which command from £30 to £65 a year, with the usual extras, and are attractive chiefly as stepping-stones to a higher appointment. The positions of labour master and labour mistress, involving supervision of the able-bodied paupers during the performance of their daily tasks are open to candidates who have no previous experience but who can furnish proof of being good disciplinarians. For male officers, ex-sergeants and corporals of the Army are in request; while a knowledge of steam laundry work is frequently a strong recommendation for the post of labour mistress. The limits of age are usually 25 to 40 for men and 25 to 35 in the case of women. Masters are paid £30 to £36 a year, and mistresses about £5 less. The average rate of pay for yardsmen, wardmen, and porters is £27 to £32 yearly. Apart from the ordinary domestic servants, these officials complete the executive staff. Every workhouse also has a small number of skilled operatives, including generally a fireman or engineer at £80 or £90 a year; a baker, receiving £60 or £65; a tailor, shoemaker, and male cook, each earning about £1 a week; and laundresses, at £25 to £35 a year.

The Casual Wards. These institutions are sometimes part of the workhouse itself, but often are at some distance from it. They are designed for the reception of tramps and other "casual paupers" of both sexes, and are in charge of a superintendent and matron, whose

duty it is to give their squalid guests the lodging and scanty fare prescribed by the regulations, and to insist on the performance of a proper task of work in return. The qualifications required of these officers, and their earnings, are practically those of the labour master and mistress, which have already been discussed.

Hospitals and Asylums. The Poor Law infirmary or hospital is on practically the same footing, in respect of its medical and nursing staff, as the asylum for pauper lunatics and imbeciles. These two classes of institution may therefore be considered together. In discussing them we may adopt the convenient method (already followed more than once in this course) of selecting a leading and typical authority and commenting on such differences in the conditions of employment as distinguish it from less important bodies.

The "M.A.B." In its Poor Law administration, as in so much else, London affords us the most striking instance of this class. The Metropolitan Asylums Board, popularly known as the "M.A.B.," was created by the Metropolitan Poor Act of 1867, to furnish proper provision for the imbecile poor, and for others who were stricken with fever or smallpox. It now owns 12 great fever hospitals, three others for smallpox, five imbecile asylums, and a training ship and medical homes and schools for workhouse boys. These are controlled by 73 managers, 55 of whom are elected by the London boards of guardians, the remainder being nominated by the Local Government Board.

Through the courtesy of the clerk, Mr. T. Duncombe Mann, we are furnished with authoritative particulars as to the staff of this great Poor Law association. In respect of medical appointments, the following details are given.

Infectious Hospitals. There are 12 medical superintendents at £400 a year, rising £25 annually to £700, all with unfurnished houses, coal, light, and washing, and some receiving extra remuneration for acting as clinical instructors to medical students. These officers are in supreme control, and their duties are, therefore, very wide-reaching. About 50 assistant medical officers are employed, in two grades. Those in class 1 receive £280 the first year, and afterwards £300 per annum ; while for class 2 the scale of pay is £180, rising £20 annually to £240—all with board, lodging, and washing. Among the assistant officers about 14 vacancies occur yearly.

Imbecile Asylums. Medical superintendents receive £600, rising £50 yearly to £800, with the same allowance as in the hospitals. Their staff of 14 medical assistants comprises three classes of appointment. The scale of pay in the first class is £250 to £300 ; in the second, £180 to £200; and in the third, £150 to £170, in each case advancing by £10 yearly. All assistants receive also board, lodging, and washing.

The medical officers of workhouse infirmaries are less liberally remunerated. Where several resident doctors are required—as in the larger London unions—the senior officer may receive between £350 and £450 a year, and his assistants from £120 to £250 or £300, according to their grade. But there is no uniformity in the rates of pay offered by the guardians, and in country areas the scale is often lower.

Matrons and Nurses. The responsible officer in charge of the nursing and household establishment in Poor Law hospitals and asylums is the matron. Her post is generally admitted to be an arduous and anxious one. With or without the aid of an assistant, she is required to superintend the work of her staff of nurses, to train the probationers, and, while thus attending to the professional side of her duties, to secure the smooth working of the whole institution by careful regard for a thousand domestic details. These duties need a qualified nurse who is also a capable, energetic organiser; and well paid as she is, the matron fully earns her salary. In nursing institutions generally, her normal rate of pay as a resident officer is from £80 to £100 a year, and her assistant receives about half as much.

Respecting the Metropolitan Asylums Board service, Mr. Mann writes : "The matrons of the Board's institutions must all be trained nurses ; the pay varies from £100 to £150 a year, according to importance of position. In each case full resident allowances are granted. In the case of the medical schools the matron is head of the institution; but in the case of the asylums and hospitals is not, the medical superintendent being in charge. The whole number of matrons employed is about 27."

Nurses under the M.A.B. The staff of nurses employed by the M.A.B. is a very large one ; it varies considerably from time to time, but generally numbers about 1,200, the great majority being employed at the Board's hospitals, and a few in the asylums and institutions for children. The appointments made are of three grades—namely, as charge nurses at £36 a year, rising to £40 ; first-class assistant nurses, £24—£28; and second-class assistants, £20—£24 ; the increment in each case being an annual one of £1. Full resident allowances are provided in each grade. The annual leave for charge nurses is four weeks, and for the rest three weeks.

Candidates for Appointment as Nurses. Applicants for the position of charge nurse must be at least 25 years of age, and are required to provide certificates of three years' training in either a general hospital with a recognised school for nurses, or "a Poor Law infirmary in which systematic instruction is given and tested by subsequent examination by an independent authority." These officers are eligible for promotion to the position of superintendent nurse and matron. Assistants of the first class must be 23 or older, and must have undergone a year's training at one of the institutions already mentioned. Two years' service in this grade is essential for advancement to the next. For second-class assistant nurses no proof of training is required. Candidates must be at least 22 years of age, and must serve for two years before becoming eligible for promotion to the first class,

unless they have had a year's previous experience in a hospital or infirmary. Promotion and increments are in all cases dependent on the recommendation of the chief medical officer and the matron.

Confusion in the Nursing Service. The Poor Law nursing service, as a whole, exhibits no such uniformity of system in respect of either salaries or qualifications.

Some boards of guardians require merely that applicants shall have had a year's experience in a public institution, while others insist on two or three years' systematic training in a recognised hospital school; and those boards with a large hospital or infirmary under their control generally prefer to train their own staff as far as possible. For general infirmary duty, the L.O.S. certificate in midwifery is a valuable qualification.

For head or charge posts, the usual age limits are 25 and 35 or 40 years, and for assistants or probationers, 21 and 30. Fully trained and certificated nurses are paid from £32 to £45 as resident officers—or £65 to £85 if non-resident—according to the liberality or otherwise of the guardians and the importance and responsibility of the appointment. The initial salaries of those who are less highly qualified, or hold assistant rank, vary in the same way between £30 and £21, or occasionally as low a limit as £18 a year. The following are average figures for probationers: Two years' training, £12 and £16; three years', £10, £16, and £20. It is commonly stipulated that applicants for nursing posts must be either widows without dependent children, or single women.

Position of Poor Law Nurses. The position accorded to Poor Law nurses varies no less than their stipends. The Metropolitan Asylums Board is careful to provide each officer, as far as possible, with a room of her own, and expressly declares that "The nurses rank as a class superior to and separate from the other members of the female staff, and are boarded and lodged apart from the remainder of the hospital staff." But in small infirmaries these officials are sometimes far less punctiliously treated. In this respect, as in others, the service needs to be established on a uniform basis.

A brief reference may be made here to the attendants of either sex employed at Poor Law asylums and hospitals. The rates of pay and conditions of entrance very closely resemble those already given relative to the posts of labour master and mistress. For an attendant's position the qualifications most in request are good character and bearing, sound health, and physical strength.

Stewards and Storekeepers. The terms on which these officers are employed in the larger institutions of the guardians are well exemplified by the following particulars respecting the Metropolitan Asylums Board, which are communicated by the Clerk of that authority.

"Clerks and storekeepers and stewards may be properly classed together. Their pay ranges from 40s. a week, with no resident allowances, to £300 a year, with full allowances, according to the size of institution to which they are attached and the extent of their duties. These institutions vary from a convalescent home for 100 children to an imbecile asylum for 2,000 patients. No technical qualifications are required, but, other things being equal, a man with some experience of the Poor Law system of keeping accounts (which is special and rather complicated) would probably have some preference. The duties consist of keeping the books of account with regard to the institution, receiving and distributing all supplies and stores, acting as clerk to the institution, and of supervising to some extent certain of the male staff; and, in institutions to which land is attached, their duties embrace the control of the farming and other operations."

This section of the Metropolitan Asylums Board staff includes twenty-seven principal posts and a considerable number of subordinate ones. An excellent way of entering is as steward's junior clerk. These officers, who must not be less than eighteen years of age on appointment, receive £40 a year, rising to £50, with board only. Their duties afford the best of training for an assistant stewardship, which is remunerated with £80 a year, advancing by £5 annually to £100, as well as full indoor allowances. Thence, for a capable official, promotion to principal rank should be assured.

Schools and Cottage Homes. These special centres for pauper children form an invaluable means of rescuing young lives from the dismal associations of the workhouse. For our purposes, however, the union school may be dismissed in a few words. It is generally controlled by an experienced superintendent and matron—the latter in many instances a trained nurse—at a joint salary of £120 to £200, with apartments and other advantages. It has its own small staff of teachers, who are often ill-equipped and indifferently paid. Properly qualified instructors of either sex will usually find the County Council a more satisfactory employer than the Board of Guardians.

Cottage homes are practically Poor Law colonies, in wholesome surroundings far from the taint of cities. Each house has its quota of youngsters under the care of a foster-mother—often a kindly-natured widow—who in return for wages of £20 or £25 a year and emoluments cooks and washes for her adoptive family and trains its girls in domestic ways. Sometimes a young or middle-aged married couple is in charge instead—in which case the husband's share is the care of the boys out of school hours, and a salary of some £30 or £35. For these posts, experience of children and the absence of "encumbrances" are generally essential. Humble as the work is, it is at least more pleasant than much that falls to the lot of Poor Law officials.

Our survey of the Municipal Service is concluded, and we now turn to a new branch of our subject—the National Service.

Municipal Service concluded.

ELECTRIC TRAMWAYS

Properties of Series Motors. Motor Construction. Control of Tramway Motors. Tramcar Brakes. Overhead Construction. Bonding the Rails

Continued from page 1909

By Professor SILVANUS P. THOMPSON

ONE of the earliest industrial applications of electricity was to the driving of tramways. The first electric tramway was installed by Siemens, of Berlin, in 1882; and the system was quickly taken up and brought to a high state of development by American engineers, owing to the bad roads rendering this form of suburban and intra-urban locomotion practically the only possible one. It is remarkable that the system of traction early adopted is the one which commands practically universal acceptance until the present date. It consists essentially of (*a*) a supply of *continuous current* at 500 to 550 volts, generated in (*b*) a *central power-house*, and transmitted to the cars by means (*c*) of *overhead conductors*, whence by contact with a trolley wheel on a pole on the car it is led down to (*d*) *two series-excited motors*, which are placed electrically first *in series* with one another *at starting*, and then *in parallel* with one another when a sufficient speed has been attained.

Tramway Systems. The only recent modifications (and these have been adopted only in certain exceptional cases) are the substitution of a supply of current from sub-stations where a high voltage alternating current is converted to continuous [see SYSTEMS OF SUPPLY]; the adoption of underground conduits or of methods of surface-contact in place of overhead wires; and the use in hilly districts of shunt-excited motors. A few lines are indeed operated by alternating currents, but they are exceptional. The chief technical interest, therefore, turns on the application of continuous currents by the use of two series-excited motors on the car, since it is this particular combination which has shown itself best adapted to the needs of tramcar propulsion. These needs are, in the first place, a great starting effort when the car begins to move, and, secondly, means of changing the propelling effort as required by the changes of speed and the exigencies of ascending or descending gradients. Attention must therefore be first directed to the properties of the motor, and then to the methods of electrically controlling its speed, its effort, and the amount of current which it draws from the lines.

The Series-excited Motor. On page 1325 we discussed the different methods of exciting the field-magnets of generators. The same arrangements can be used for exciting motors, though, of course, the motors will have different characteristics of working when used under the different conditions.

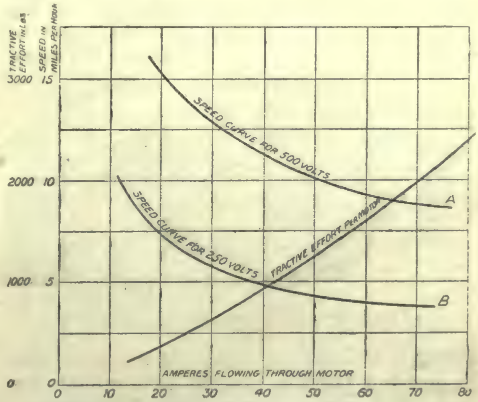
Just as the shunt dynamo is the one principally used at the present day, so the shunt motor, with the notable exception of traction work, is almost exclusively used for power purposes. The article beginning on page 1590 was taken up wholly with a discussion of the shunt motor; we have now to study the series motor in connection with its only present-day application.

The characteristic properties of a series motor are generally considered with reference to the current which it takes, and are expressed in the form of curves, such as are shown in **129**.

To help in the study of these we may classify in parallel columns the properties of the series and the shunt motor as follows:

SHUNT MOTOR	SERIES MOTOR
The *speed* is practically constant at all loads, and therefore independent of the current flowing through the armature	The *speed* varies, and is high with a small current and vice versâ, because the magnetism is created by the same current which eventually flows through the armature, and therefore alters with it, and a high speed is necessary to generate the same voltage with a smaller amount of magnetism.
The *torque* [page 1592] or *tractive effort* is directly proportional to the current, again because the magnetism is constant.	Because the magnetism increases with the current, the *tractive effort*, which depends upon both the magnetism and the armature current [see page 1592], is relatively greater with large currents.

It is the combination of these two qualities which makes the series motor so valuable for



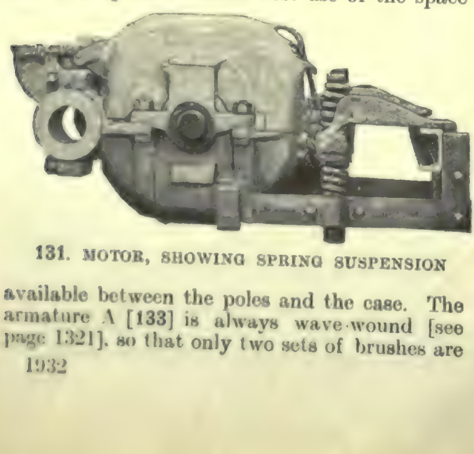
129. CHARACTERISTICS OF SERIES MOTOR

traction purposes, for at starting, when the greatest tractive effort is required, this effort is greater per unit of current than it would be with a shunt motor, and the natural speed of the motor is low when a large pull is required. The advantage of the latter is seen when the car is climbing a hill, for if a shunt motor were used it would require to run at practically the same speed as on the level, and an excessive demand of power would be required from the line.

Construction of Tramway Motors. The manufacture of tramway motors is an art which has been acquired only after years of experience. A minimum amount of space is available underneath the car, and the motor has to be totally enclosed to protect it from the weather. The construction of the various parts must be without fault, for they have to withstand the heavy strains ranging from an expeditious starting up under the maximum load to those due to an emergency braking.

The motor itself is invariably of a four-pole design, and a typical example is illustrated in **130**, **131**, **132**, and **133**. Fig. **130** gives a view of the complete motor ready for mounting on its truck. The box-like casing, which also serves as the yoke of the magnetic circuit, is of the best cast steel, and is made in two parts, which are hinged so that it can be conveniently opened for examination, as in **133**. With one half of the box are cast the brackets which form the bearings of the car-axle and other details necessary in mounting the motor [see **131**]. In tramway work the motor is never placed directly on the wheel axles, but drives through a reduction spur-wheel gear, the ratio of the speed of the motor to that of the wheel axle being from 3·5 to 1 to about 5 to 1. By adopting this arrangement the motor may be mounted on springs [**132**], which take up all the jolts and jars from the road, and thus protect the motor to a considerable extent.

To minimise the energy-losses in the iron of the magnet core, it is generally built up of laminations riveted together. In the motor shown there are four magnet-poles. Two of these, marked MM in **133**, are in the lid, the other two are in the lower part underneath the armature A. The pole-cores are as short as possible, and the exciting coils EE are wound on formers to such a shape as to make best use of the space

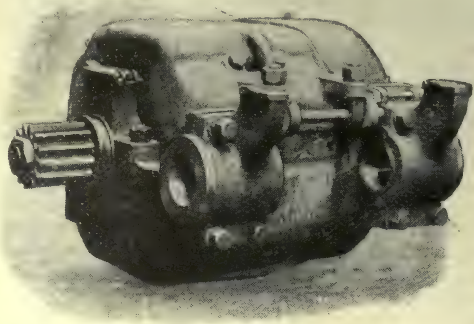


131. MOTOR, SHOWING SPRING SUSPENSION

available between the poles and the case. The armature A [**133**] is always wave-wound [see page 1321], so that only two sets of brushes are needed [**68**, page 1322], and in this way the whole of the brush gear becomes easily accessible for inspection and repair, as in **132**. The brushes BB themselves are of carbon, covering two or three commutator segments, and are fixed once and for all in the neutral position [page 1323], because the motor is required to run in both directions.

When the motor is closed, they press on the commutator C at parts distant from one another by a quarter of the periphery. P is the pinion of the speed-reducing gear.

The laminations of the armature are extra thin, and are carefully selected for their magnetic qualities. The slots in the tramway motor arma-



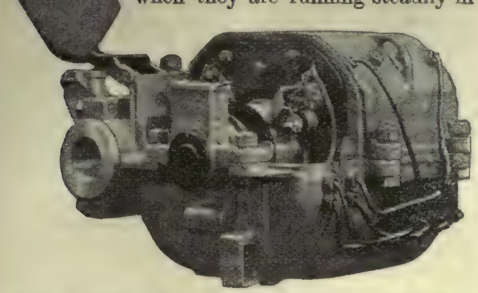
130. TRAM-CAR MOTOR (Witting, Eborall & Co.)

ture are relatively larger and fewer than in other types, for by this means the total space taken up by insulation is somewhat reduced.

The Control of Tramway Motors. We have already said that tramway motors are connected in series at starting and afterwards in parallel. The reason is one of economy, for at the start the value of the current is controlled solely by the insertion of resistance in series with the motor, just as in the case of the shunt motor [page 1594], and we may just as well let the same current pass in succession through both motors as take double the current from the line and send it in two branches through the two motors. The various stages in the control which follow are diagrammatically shown in **134**. After the car has once started moving, the next operation is to cut out the resistance, generally in three stages, for the current value becomes more and more determined by the speed of the motor than by the resistance in series with it. When all the resistance is short-circuited [**134**c] the car gradually attains a steady speed, and the current consumed will be that necessary to provide a tractive effort in the two motors, just sufficient to overcome the running friction of the car.

Suppose in our motors [**129**] that this tractive effort were 1,000 lb., this being divided equally between the two motors, we see from the curve that for a tractive effort of 500 lb. each motor is requiring 25 amperes, and that according to the curve B, which represents the relations for series connections, the speed will be 6·2 miles per hour.

Parallel Connections for Top Speed. Under certain conditions—for example, on a long hill—it is advisable to continue to run with the motors in series, but often a higher speed is required. We put the motors in series to economise current at starting; we now put them in parallel to attain a high speed when the car is well under way, for the speed is dependent on the voltage, and when they are running steadily in



132. MOTOR: END COVER OPENED, SHOWING COMMUTATOR AND BRUSHES

series, the voltage on each motor is about 250, while if we could get them running steadily in parallel—*i.e.*, each straight across the mains—the voltage across the terminals of each would be 500, and a high speed would result, as shown in curve C [**129**].

The transference of the motors from series to parallel must be done in stages, for resistance must first be introduced to limit the rush of current which takes place when the motor connections are altered from **134***c* to **134***d*. This resistance is then cut out in stages, as shown in **134**, *d*, *e*, and *f*. With conditions **134***f* a steady speed is again attained, and to continue our example, we will take it that at this increased speed a larger tractive effort of 1,500 lb. is required. With 750 lb. effort per motor we see [**129**] that about 34 amperes are required per motor, and this time twice this amount—namely, 68 amperes—will be required from the line. Referring to curve A, we also see that the speed (corresponding to these 34 amperes per motor) will now be about 12 miles per hour.

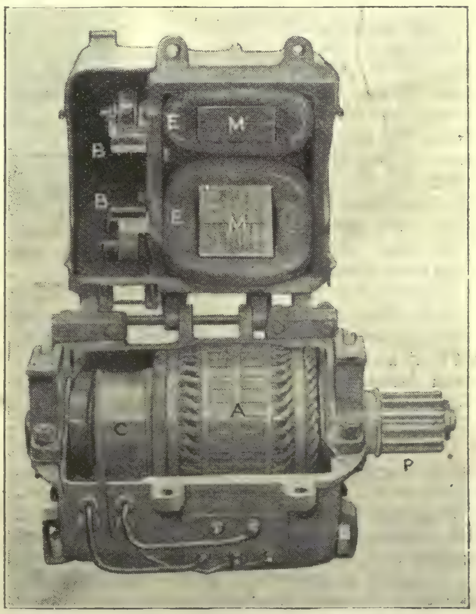
The Tramcar Controller. The controller is really a series of switches by which the driver, by moving a handle, performs, in successive stages, the operation of cutting out resistance and of placing the motors in series and in parallel with one another as required. The principle of the apparatus is shown in **135**. By this it will be easily understood that as the handle is moved round in the direction indicated, and more of the wipers come in contact with the serrated copper-plate upon the controller drum, more of the resistance is cut out. The reader should follow out the path of the current in the position sketched, and the diagram **135** should be compared with the upper part of the actual apparatus shown in **136**, in which the serrated plate takes the form of strips which are connected electrically by being fastened to the same brass spindle.

Series-parallel Contacts. Fig. **137** is a developed diagram to show the operation of switching the motors in series and parallel. When the controller is in the *series positions* the current flows through GI, *a*, H, and J, and the motors are thus in series; and when in the *parallel positions* the current divides at G and flows thus:

$$G < \begin{smallmatrix} b\ H \\ I\ c \end{smallmatrix} > J.$$

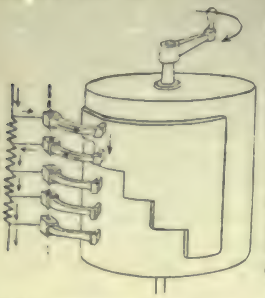
Reversing the Motors. This is generally performed by a separate drum, one type of which is shown diagrammatically in **138**. To reverse the direction of rotation of a motor, the field current has to be reversed with respect to the armature, and this is done by moving the drum to the left or to the right so that the metal plates A and B come into contact with the left-hand or right-hand set of wipers. In the former case the path of the current is $+\,M'dN'XYO'eP'Z\,-$, and in the latter $+MdNYXOePZ\,-$, so that, while the direction Z to $-$ remains the same, the direction between X and Y is changed.

Tramway Trucks. Small cars are mounted upon single trucks with a motor mounted upon each axle of the truck. As, however, it is not practical, from the point of view of rounding curves, to have the wheel base—*i.e.*, the distance between centres of the wheels of a truck, much more than six feet, it becomes necessary to mount the larger cars upon two trucks. In the inter-urban cars much used in America, each axle is again used for driving and four motors in all are installed, but the usual practice in England is to have only two motors, one on each truck. By this arrangement a certain percentage of the weight



133. MOTOR, OPENED, SHOWING ARMATURE AND UPPER PAIR OF MAGNET POLES

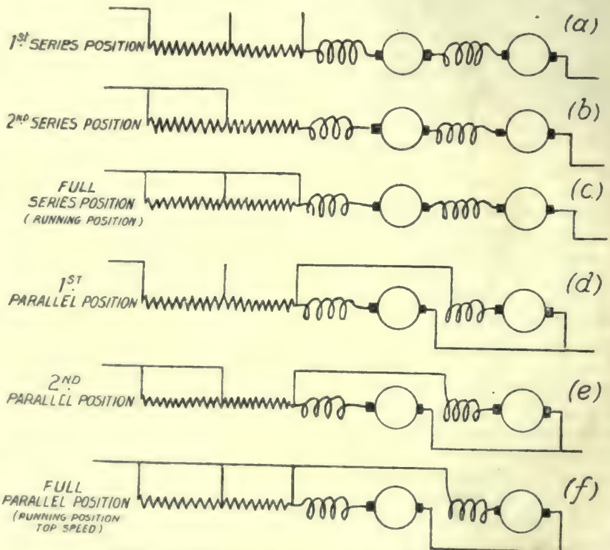
of the car is lost for tractive purposes, and the driving wheels will slip sooner. To get over this the car is mounted on the trucks as indicated in 139, so that the weight is taken nearer the driving wheel than the pony wheel, and in this way from 75 to 80 per cent. of the weight of the car is used for giving adhesion to the rail when driving.



135. PRINCIPLE OF CONTROLLER DRUM

Brakes. The safety of a car depends upon the reliability of its brakes, and these should, therefore, receive the best attention. All the different forms of brakes may be divided broadly into three classes—namely, wheel brakes, track brakes, and electric brakes.

Rim Brakes. Of the first the best known form is where cast iron or hard wood brake shoes press against the rim of the wheels. The limit to the power of this form of brake is the adhesion of the wheels to the rail. When the brake shoes are pressed so hard against the wheel that the grip between the wheel and the rail is overcome the wheel slips, and it has been found by experiment that when the wheels start slipping they continue to slip even after the brake pressure has been considerably relieved, and that at the moment of slipping the braking action *becomes reduced to a third of the former value when the friction was all at the brake shoe.*



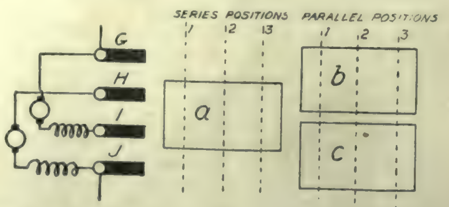
134. DIAGRAM OF STAGES OF CONTROL

The question of the distribution of the weight of the car on the wheels comes up again in connection with this question of wheel brakes. If most of the weight rests on the driving wheel, it is obvious that if all wheels are provided with brakes, the pony wheels will tend to start slipping first, so that, in order to prevent this, the lengths of the rods which transmit the pressure to the several wheels are so proportioned that the leverage on the driving wheels is relatively greater than that on the pony wheels, and all wheels tend to slip at the same time.

Track Brakes. In the second type of brake—namely, the track brake—a shoe is pressed down on the track, and the limit to this form is, of course, the weight of the car; for any downward pressure on the rails is counteracted by an upward force which tends to lift the car off the rails, or, if not altogether lift it, to relieve the wheels of a portion of the weight of the car and so make their running less certain. This objection is, however, got over by making an electromagnet of the brake shoe and producing the necessary pressure by the magnetic attraction between the iron shoe and the steel rail.

Motor-generated Brakes. The third form of brake is that in which the motors are made to act as generators, and the energy they produce as such is of course taken from the moving car, with the result that it is retarded. The generated current is often passed through resistances, but it may be used to excite the magnets in the previous type of brake. The Westinghouse Co. have on the market an emergency brake in which the motors are made to act as generators and the current so derived being sent round the coils of the slipper brake. The attraction of this to the rails also actuates the wheel brakes, so that all three types of brake are instantly applied by a movement of the controller handle.

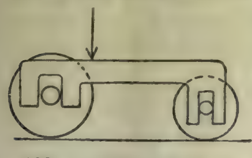
The Return Circuit. To provide an efficient return path for the current after it leaves the trams is always an important matter. In telegraphy the currents are allowed to return for hundreds of miles through the earth; for here the currents are small. With electric cars, it was found that, with the large currents



137. ARRANGEMENTS FOR SERIES AND PARALLEL

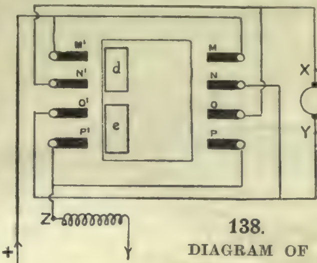
used, neighbouring gas and water pipes became damaged. With a view to protecting these pipes the Board of Trade have made rules, the

most important of which is that on no part of the return circuit shall there be at any time more than seven volts above the negative terminal of the generator. To ensure that this is so, among other things, the separate lengths of rail which form the track must be connected together electrically. The means used for mechanical fastening are not sufficient for the electrical purpose, so that special arrangements have to be adopted. In some systems, the lengths of rail are welded to one another, but the usual way is to bond the rails with thick copper connectors which are firmly riveted into adjoining rails. Fig. **140** shows a well-known type of bond. Holes are drilled into the web of the rail and they must be thoroughly cleaned before they receive the shank of the bond. When this has been fixed firmly in place, a hard steel stud is then forced into the hole down the centre of the shank, with the result that the bond and the rail are forced into very intimate contact. It is found that by far the greater part of the resistance of the bond is in the contact between it and the rail, so that the greatest care must be taken to see that the rivet is right home. As a further precaution the various track rails are cross-bonded at intervals.

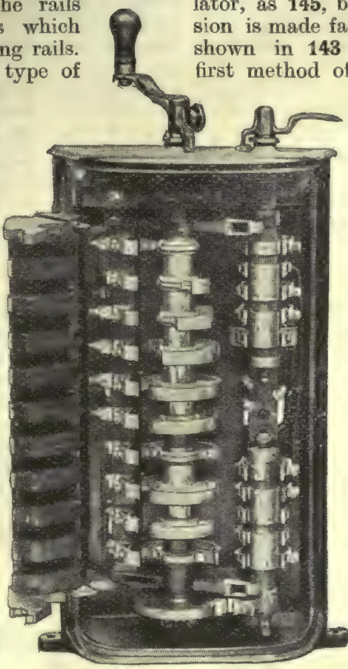


139. DISTRIBUTION OF LOAD ON TRUCK

Overhead Construction. The problem in overhead construction may be stated thus: *Suspend a copper wire, of diameter about ½ of an inch in such a way that great mechanical strength is obtained, and with an insulation sufficient to withstand* 500 *volts.* As regards the poles, three methods of construction are used in England—namely, (1) a side-pole on one side of the road with a long bracket which supports both the up and the down wire; (2) a centre-pole along the middle of the road, with short brackets on each side; and (3) poles on both sides of the road, the conducting wire of copper being slung from a steel suspending wire stretched right across the road. Of these three the second makes the best mechanical job, although in busy thoroughfares it is out of the question. The first is cheaper than the third in other cases where the width of the road would not necessitate an extra long bracket. The wires themselves are supported by soldering their ends into what are known as *ears* [**141***b*], which are screwed into *insulators,* such as **141***c* and **142.** The whole arrangement is then slung as shown in **143** and **144**; a second insulator, as **145**, being inserted before the suspension is made fast to the pole. The constructions shown in **143** and **144** are adopted for the first method of suspension mentioned above, **143** showing the arrangements on straight runs of line, while **144** is the arrangement which is used on curves, where the wire must be on the same level as the tackle which takes the side thrust from the trolley-pole.



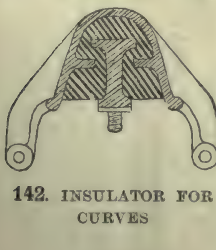
138. DIAGRAM OF REVERSING DRUM



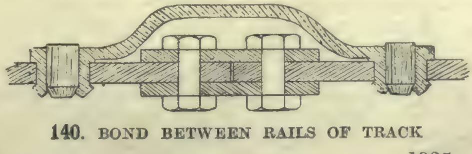
136. CONTROLLER (Witting, Eborall & Co.)

Construction of Insulators. The material used for tramway insulators is brittle, and, in consequence, cannot withstand any great tensile stress, although it is strong against compression. In consequence of this the insulators have to be so constructed that the pull between the ends is taken up in the insulator by a compression. How this is done may be easily seen by tracing out the path of the stress in the section shown in **145**, and also in **141***c* and **142**. The insulation resistance of an exposed insulator depends upon two things—namely, the material of which it is made, and the state of its surface to prevent creeping of the current along any film of moisture that may form. The section in **145** has been specially chosen to meet this last point, for the rain falling on it will not drain off on to the metal eye-pieces at the end, but will flow to the projecting rib which passes around the centre.

Special Details. For crossings, special ears, known as *frogs,* have to be provided to guide the trolley on to the required line. Other special requirements are when the line runs from one section to the next, each section being

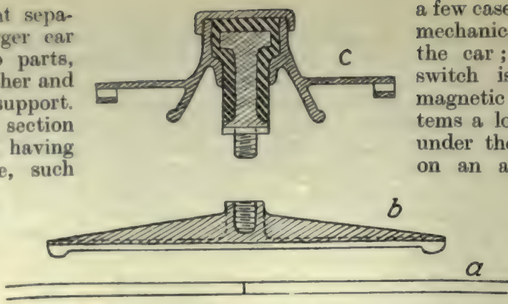


142. INSULATOR FOR CURVES



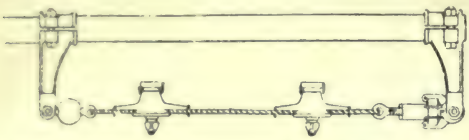
140. BOND BETWEEN RAILS OF TRACK

supplied with its current separately. For this a larger car is used, made in two parts, insulated from one another and from the common support. Many types of frogs and section insulators are used, and, having described their purpose, such and other details may be readily studied by anyone living in the neighbourhood of an electric tramway.

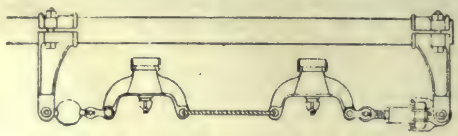


141. DETAILS OF OVERHEAD SUSPENSION

Collecting Trolley. The means almost universally adopted in England and America for collecting the current from the line is by a trolley. A trolley is a grooved wheel mounted on the end of a more or less flexible steel pole, which, in the case of cars with roof seats, is supported on a pillar about six feet high. A section showing the inside mechanism of the type of pillar used by Messrs. Blackwell & Co. is shown in **146**. The arrangements provide for the movement of the trolley-pole up and down to suit the varying heights of the overhead wire, for supplying an upward pressure to the pole, so that the trolley-wheel makes a sure contact with the wire, and for swinging the pole round when the direction of motion of the car is changed. On the Continent a bow, which slides along the under surface of the overhead wire, is often used to collect the current.

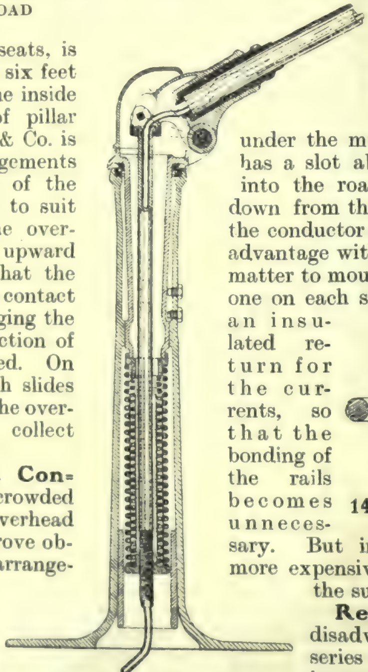


143. OVERHEAD CONSTRUCTION FOR STRAIGHT PART OF ROAD



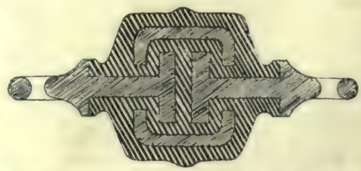
144. OVERHEAD CONSTRUCTION USED IN CURVES

Surface-contact and Conduit Systems. In crowded city streets, where any overhead construction is likely to prove obstructive, other collecting arrangements are sometimes adopted which collect the current from the road below the car. In *surface-contact* systems, the current is collected from studs set in insulating blocks of cement or asphalt in the surface of the road. At times, when no car is passing over them, these studs are "dead," being automatically disconnected from the feeding mains. The car itself when it comes over the stud must make it *alive*—that is, put it into communication with the mains by some sort of switch. In a few cases this switch is actuated mechanically by the weight of the car; but more often the switch is actuated by electromagnetic means. In some systems a long electromagnet fixed under the car acts magnetically on an armature in a sunken box under the stud. In others, the electromagnet that moves the switch is placed in the stud-box, and is brought into operation by the car making electric contact with the stud. In all cases the car is provided with a long metal skate or runner under the car, which glides from stud to stud and so continually picks up the current from the mains through the studs.



146. STANDARD FOR TROLLEY-POLE

In the conduit system the live conductors are placed on insulated supports in a tunnel or conduit which runs along under the middle of the track. The conduit has a slot about 1 in. wide opening all along into the road, and through this slot is let down from the car a *plough*, which glides along the conductor and so collects the current. An advantage with this system is that it is an easy matter to mount two conductors in the conduit, one on each side of the slot, and so provide an insulated return for the currents, so that the bonding of the rails becomes unnecessary. But in any case a conduit is much more expensive than either the overhead or the surface contact system.



145. INSULATOR TO TAKE STRAINS

Regenerative Control. One disadvantage of the ordinary use of series motors is that the energy spent in pushing the car up a hill cannot be recovered when the car is running down the other side, for the energy given out by the car when running down must be absorbed in resistances, motors of this kind not being adapted to return it to the line. If, however, shunt motors are used instead, the case is altered, for then when the car is running quickly down hill the motion makes the motors act as generators, which feed the current back into the line.

Continued

IMPERIAL ROME

Claudius Proclaimed Emperor. Messalina and Agrippina. Rome under Nero. His Death. Vitellius and Vespasian

Continued from page 1832

By JUSTIN McCARTHY

After the death of Caligula there came a short interregnum. Chaerea, by whom Caligula had been put to death, was a Republican in politics, and many of the Senate had grown into revolt against the Imperial system because of the atrocities which had been perpetrated during the recent reigns, and they were also anxious to obtain once again the real control of the State.

An attempt was made to bring the Imperial succession to an end, and to set up a Republic. Chaerea and the Senate, however, were counting without the army. The soldiers were devoted to Imperialism, and their leaders found an heir to the throne. Their choice lighted upon Claudius, the brother of Germanicus; they found him in the Imperial palace, made him their captive in a friendly fashion, carried him to the camp, and proclaimed him Emperor. Claudius, who had himself no inclination for an Imperial position or public life, yielded to their demands, and the Senate saw no chance of resisting them. Claudius, who became the fourth of the Roman Emperors, was born at Lyons in the year 10 B.C. As he grew to manhood he lived in seclusion, devoting himself to study. His way of life had made Caligula regard him as a harmless, contemptible personage, and he was thus probably saved from hostile feeling on the part of the Emperor and his favourites. But the man who was thought too insignificant to be a dangerous rival became Caligula's successor to the throne.

A Weak Character. Claudius, while in seclusion, had written a history of the Etruscans and the Carthaginians—books which are wholly lost; and he wrote works in Greek as well as in Latin. He was fifty years old when he was almost literally lifted to the throne. He began his reign with good intentions, and gave promise of success; but he was weak and timid, and was always under some influence not that of his own inclination. At first he came under the influence of the army, and allowed Rome to become once again a military despotism. His armies were victorious in many wars, converted Mauratania into a Roman province, and began a new conquest of Britain. But in the meantime a conspiracy against him was plotted on behalf of new aspirants to the throne, and the discovery of this scheme made him a victim to panic, and brought him under the absolute influence of his wife, Messalina, who had a short way of getting rid of personal or political enemies. History and literature have consigned the name of Messalina to eternal infamy, and made it the synonym of profligacy and cruelty in woman. Messalina prevailed upon her timid and yielding husband to sanction all manner of cruelties and death warrants against those whom she made him regard as his most dangerous enemies, and 35 senators and 300 men belonging to the order of knighthood were put to death. Messalina carried her outrages upon law and humanity so far that even Claudius was prevailed upon to stand up against her. In defiance of all public law and public decency, she entered openly on a second marriage, although she had not been divorced by her Imperial husband. This was too much even for Claudius, and he gave his consent to the passing of a sentence of death on her, and to its execution. Claudius afterwards married his own niece, Agrippina, a widow who had, by her former husband, a son named Nero.

Agrippina. Agrippina soon showed herself an appropriate successor to the infamous Messalina. Nero was then about 11 years old, and Agrippina, who exercised for a time full control over her husband, soon made it apparent that she was determined to secure the succession to her son, and to exclude from it Claudius's son, the young Britannicus. She appointed Seneca, the philosopher, tutor to Nero. When Claudius succeeded to the throne he gave an enormous sum of money to the army, to be distributed proportionately amongst the officers and the men. This was done to secure the support of that military strength without which he did not believe that he could hold his position. This display of premeditated extravagance had an important effect on some succeeding chapters of the Imperial history. It made it the interest of the army to have as many vacancies as possible in the succession, and also left it open to those who believed they had claims on the throne to become rivals in the market for the purchase of the military support.

Claudius still continued to reign, and, although he had yielded so far to the influence of Agrippina as to adopt Nero for his successor, the Empress feared that he was not satisfied with this concession on his part, and that he might pluck up spirit and restore the natural order of succession.

There was one ready way for such a woman in such a Court to secure the fulfilment of her great scheme. She arranged for the poisoning of Claudius, and thus made the way open for the accession of Nero in 54 A.D.

Accession of Nero. Nero was but a youth when he came to the throne, and for the first few years gave good promise. He professed a love for peace, justice, and order, and the teachings of Seneca seemed to have some influence over him. One story illustrating Nero's disposition at this time has been preserved for us by his biographers. When he was called upon for the first time to sign a death warrant he

declared pathetically his sincere wish that he had never learned to write, that he might thus have escaped from so painful a duty. This condition of the Imperial mind did not last long, and Seneca soon saw that his pupil was endowed with a fierce and passionate nature which philosophy could do little to restrain. There was in Nero's temperament a singular blending of the furious tyrant and the artistic amateur. He loved music, and tried to make himself an accomplished performer, and he had a taste for the stringing together of verses—they could hardly be called poems. He had a passion for the stage and even for the arena. It was one of his delights to drive chariots and display his skill in the management of horses before the assembled multitudes in the great Roman Amphitheatre. The citizens of Rome had thus the opportunity of seeing their Emperor, who belonged to the family of Julius Cæsar, make exhibitions of himself in this unseemly fashion. Often, too, he indulged his humour for the recitation of some of his own verses on the public stage, accompanying himself with what he believed to be appropriate music on a harp.

The Burning of Rome. These were only harmless absurdities, but Nero indulged in other tastes in the fashioning of public exhibitions which were abominable even for the worst days of the Roman Empire. His reign was marked by its persecution of the Christians, which he endeavoured to justify by accusing them of having carried out a plot for the burning of Rome. A great conflagration did break out in Rome during the year 64 A.D. which caused the utter destruction of nearly two-thirds of the city. Many historians have stated that the great fire in Rome was the work of Nero himself, or those whom he employed for the purpose, but there did not seem any substantial ground for such a charge. It is said, and the story may be true, that he admired the sight of the burning city from one of the surrounding hills, while he declaimed some lines about the burning of Troy and accompanied them with his lute. Literature and poetry have many allusions to Nero fiddling while Rome was burning, and there would have been nothing out of keeping with his character if he had made the occasion an opportunity for such a display. He asserted that the fire was the work of the Christians, of whom there were many in Rome at the time, and he made this belief an excuse for the infliction of cruelties on them which were strange even to his days.

Cruelty to the Christians. Many of the Christians were by his orders wrapped up in the skins of beasts and sent through the public arena pursued by fierce dogs, who tore them to pieces for the amusement of the assembled crowds. On the occasion of a public festival in his public gardens, Nero had a number of Christians smeared all over with pitch, and at his command the pitch was set aflame and the unfortunate Christians were made to burn as living torches until they fell upon the ground, died, and then gradually burned to ashes.

Nero rebuilt the city of Rome with great magnificence, and had a new and superb palace raised for himself on the Palatine Hill. When his extravagances became coo costly even for his means, he plundered the provinces without any form of law in order to make good his expenditure. If a wealthy citizen refused to contribute towards the Imperial expenses, Nero ordered the confiscation of his property, and condemned the offending owner to perpetual exile, or, in some instances, to death.

Conspiracies Against the Tyrant. These insufferable excesses at last drove some of the Senators and the Equestrian order into a conspiracy against the tyrant, but it was discovered before it could be put into execution. Among those who were accused of having taken part in it were the poet Lucan, whose famous "Pharsalia" has still a place on the shelves of our libraries. Another of the accused and condemned conspirators was Seneca, Nero's early teacher. Lucan had been at one time Nero's friend, and they had many tastes in common; but Lucan's poetry was genuine, while Nero's was only sham, and the Emperor became jealous of the poet, and would have nothing more to do with him.

Seneca, Lucan and the rest were declared guilty and sentenced to death, and were ordered to bring about that death by opening their own veins. Seneca's wife, Paulina, was so devoted to him that she implored his consent that she should die with him. Seneca, after endeavouring to persuade her to endure life without him, consented at last to her prayers.

Boadicea's Rising. During the reign of Nero took place the famous rising in Britain under Boadicea, "the British Warrior Queen." Boadicea was the wife of a British king who ruled over the Iceni, a people occupying that part of England now known as Norfolk and Suffolk. When her husband died, one of the Roman commanders in the island seized the territory, made the queen a prisoner, brutally scourged her, and ill-treated her daughters. Cowper tells us how Boadicea, "bleeding from the Roman rods," called for "vengeance from her country's gods." Boadicea escaped from her captors and raised a large army to defend the British soil. Her army defeated the Romans at Colchester, occupied London, and destroyed in their battles, so Tacitus tells us, some 70,000 Romans. Boadicea's victory seems to have been only a sudden surprise which disarranged the preparations of the Roman garrison. The Roman Governor of the island was absent in Anglesey when Boadicea's movement broke out, but returning, advanced against her and inflicted an overwhelming defeat on her army. The historians state that the Roman army had only 10,000 men, while the British forces numbered 200,000, and that the British loss amounted to 80,000 killed, while that of the Romans did not exceed 400. We must bear in mind that we have to depend on Roman historians for the details of these events, and it is not unreasonable to assume that they made the most of the Roman

victory. What is certain is that Boadicea was completely defeated, and in her despair, took poison and died.

Rome Weary of Nero. The Roman world was growing weary of Nero, and Nero appears to have been growing weary of the Roman world. He made an expedition to Greece not with the object of effecting any great conquests there, but for the purpose of displaying his own skill in dramatic performances and in games of strength and athleticism. Either Nero's good opinion of himself was fairly justified, or the Greek spectators were disposed to be very generous with their plaudits to the Roman sovereign, for Nero seems to have made quite a triumphal progress, and even at Olympia—the historic ground of the famous Olympian games, where stood the colossal statue of Zeus, by Phidias—Nero's feats were actually rewarded with a prize. He expressed his gratitude for the honours paid him by proclaiming the liberty of Greece, but it does not seem that Greece benefited much by his cheap generosity. He returned to Rome, where the people in general were thoroughly tired of his tyranny, his cruelty, his utter indifference to the welfare of the State, and his absurd eccentricities. A conspiracy was formed against him, led by some influential public men, and Nero soon found that he had no powerful friends left in the capital or in the State. He fled from Rome and hid himself in the farm of one of his freed men, one of the very few friends he had left to him on earth. He realised that there could be no safe refuge for him on Roman soil, and that there was no time for him to make his escape into any foreign land.

Nero Commits Suicide. When he heard the trample of the horses of his pursuers from Rome who were riding to his capture, he resolved to put an end to his life with his own hand. His latest words were characteristic of his extraordinary self-conceit. "What an artist," he exclaimed, "perishes with me!" Then he plunged a dagger into his throat and died. The line of the Cæsars came to an end with the death of Nero. That line, however, had not been continued even thus far by actual family descent. The succession, as we have seen, was brought about in some instances by the arrangement of legal adoption. But the line of the Cæsars brought to a close a most memorable historic chapter of history, and it is not easy to imagine any stranger anti-climax than is represented by that Imperial line which began with Julius Cæsar and came to an end with Nero.

Then began a struggle for the creation of a new Imperial line. The movement against Nero, which had ended in his death, was mainly promoted by Sulpicieus Galba, a member of a powerful family. Galba had been a Consul, had charge of the government of Gaul and afterwards of some of the Spanish provinces. He had made himself popular with the army and when the plot against Nero was organised, the Prætorian guards had been promised in his name, though it does not seem by his authority, a huge money gift if they would adopt his cause in the contest for the throne.

Galba Proclaimed Emperor. Galba came to Rome at the time of Nero's fall, offered himself as a candidate for the succession, and was proclaimed Emperor. His reign was very short—lasting only about seven months. The lavish gifts which the soldiery expected did not come and historians credit Galba with the honourable declaration that he chose his soldiers, but did not and would not buy them. Galba, during the short opportunity given him, did not display much capacity for dealing with a great crisis, and made himself conspicuous only by his extreme parsimony and reckless severity when he met with opposition. There was a rising of the soldiers against him chiefly inspired by Otho, a former friend of Nero, and an ambitious man. Otho had during Nero's reign governed some of Rome's foreign provinces, but when the uprising against Nero became serious, Otho, putting aside all his past associations, became filled with the idea that as his old friend and sovereign was now out of the way there was no reason why he should not himself be chosen Emperor. Otho became one of the adherents of Galba, but when he found that he had other views as to the best candidate for the throne, Otho turned against him, sought and obtained the support of the military and was proclaimed Emperor by the soldiery who put Galba to death.

Vitellius. In the meanwhile a new claimant had arisen, with a powerful force behind him. This was Vitellius, the commander of the Roman legions on the Rhine. Vitellius, although he had never displayed great military qualities, had succeeded in making himself popular with his soldiers, and when the rising against Galba took place, the legions of the Rhine proclaimed Vitellius Emperor at Cologne.

His troops marched through Italy and defeated the troops of Otho in a decisive battle. This defeat so disheartened Otho that he killed himself and thus left Vitellius master of the political and the military field. Vitellius was proclaimed Emperor at Rome. He was not, however, statesmanlike enough to see that his fabric of Imperial greatness stood on a foundation of sand. The manner in which he had been raised to the throne might have afforded him obvious reasons for distrusting the solidity of such a success. He had been proclaimed and, practically, created Emperor by the legions of Rome in one of her foreign provinces, and this might have served to remind him that there were other Roman forces, equally great, in other foreign provinces, which had not sustained his candidature, and which might at any crisis raise up a rival.

But Vitellius persisted in acting as if nothing could threaten his position. He did all he could to retain the devotion of his legions, allowing them the fullest license in their dealings with civil affairs while all he asked for himself was the indulgence of his own pleasures, among which a love of eating and drinking was the most dear to him.

The period was one of great anxiety for Rome. There was a great rising in the Jewish provinces, and the commander of the army sent

to subdue that rising was destined soon to make an historic name. This was Vespasian, who was born of humble family, but who showed much capacity for political and military life, who had risen in the army and served in Germany and in Britain. He was conducting the military operations for the suppression of the Jewish rising when the struggle began between Otho and Vitellius. The Roman troops in eastern regions took example from the conduct of the legions of the west. They had proclaimed their commander Emperor of Rome, and now the army of the east thought the time had come for them to assert their right of election, and in the city of Alexandria they proclaimed Vespasian Emperor.

Vespasian. The same ceremony was performed in other eastern cities, and Vespasian was called upon by his supporters to go to Rome and claim the throne. Vespasian saw that the situation was not only serious but critical, and we may suppose that he considered the condition of Rome, then and for some time past, absolutely intolerable, that he had patriotism enough to wish to help towards the setting right of the Empire, and sufficient faith in himself to believe that he could accomplish his purpose. He left his son Titus to conduct military operations in the east, and as he had to superintend affairs in Egypt he sent one of his commanders to march upon Rome. Before he could arrive, however, the legions who were engaged in the dethronement of Vitellius had captured Rome, and Vitellius had been put to death. Vespasian, therefore, found no difficulty in his way when he arrived in Rome and accepted the position of Emperor.

The reign of Vespasian opened amid severe struggles in Judea and also in some of the German and the Gallic provinces of Rome. The uprising among the Jews proved to be serious. The Jews resisted the Roman soldiers with all the hereditary courage and perseverance of the Maccabees. Josephus, the Jewish historian, took a leading part in the defence of his country.

The Capture of Jerusalem. The arms of Rome prevailed and the city of Jerusalem was captured by the soldiers of Titus. Josephus had been made a prisoner by the Romans, and was a captive in the Roman army at the time when this event occurred. Jerusalem had borne with heroic and desperate resistance the siege of the legions of Titus, but the result was inevitable, and the Romans entered the city. The conquerors behaved as conquerors were in the habit of doing in those days. They burned the great Temple of the city, and dispersed its very ashes by passing the ploughshare over its site. They caused an immense flight of the inhabitants from the land of their birth, which was the beginning of the dispersion of the Jews which went on for so many generations.

During the wars in Judea and in the European provinces of Rome Vespasian was doing his best to restore order to his capital and his country. He removed many unfit and corrupt office holders who had been put into power by Nero and other Emperors. He reorganised the financial system, which was in utter confusion; he restored the Capitol, which had been reduced to ruins by the great fire; he built the Coliseum; established a great public library, and appointed a number of State-paid teachers to give instruction in literature and rhetoric.

The exponents of the Stoic doctrines in Rome were loudly proclaiming republican principles, and Vespasian thought it his duty to expel them from the country. He had so little inclination for war and conquest that, owing to his influence, the Temple of Janus remained closed, showing that peace prevailed throughout the land. Janus was one of the ancient Latin divinities, and the opening or closing of his temple gates denoted a state of war or peace. Vespasian lived after the simplest fashion, and the habits of his court life were in striking contrast with the luxury and extravagance of some of his predecessors. He so steadily avoided all unnecessary expense that he was accused of avarice by some of his contemporaries; but it does not appear that love of laying up money formed any motive for his simple and modest life. Wherever and whenever money was wanted for any purposes of value to the State and the public he always had an open hand.

A New Atmosphere in Rome. His influence and example accomplished much for the reform of morals and manners in Roman society, and an atmosphere of purity and patriotism breathed once again throughout the State. Vespasian was entirely without affectation, and not only was he totally unashamed of his humble origin, but he treated with scorn the attempts of some of his adherents to trace out for him a lineage which might bring his family into the sphere of aristocracy. The later years of his reign were marked by few events of great historical interest. One of these was the rise into reputation and fame of Julius Agricola, who held for seven years the government of Britain. He subdued completely the whole of that island, with the exception of the Highlands of Scotland, and ruled with such moderation and justice that he all but reconciled the British people to the domination of Rome, and succeeded in making the study of Roman literature and art a favourite occupation among the intelligent classes. His daughter was married to the illustrious historian Tacitus, who has written that life of his father-in-law which is a classic in our days as it was when Rome was still mistress of the world.

Vespasian's health broke down in 79 A.D., and he went to recruit his strength to his country home in the Sabine mountains. But the removal came too late to effect any change in his condition, and in the middle of that year he died. When he felt his last moment approaching, he said to those around him, some of whom had wished to gratify him by proclaiming him a divinity, "Just now I begin to believe that I am becoming a god." This was evidently a closing touch of his characteristic humour, and he added, "An Emperor ought to die upstanding," made a sudden effort to rise to his feet, and then died.

Continued

THE NERVOUS SYSTEM

The Conscious Mind and the Unconscious Mind. Their Separate Systems and Work. Their Structure. Work and Nourishment of the Nerves

Continued from page 1800

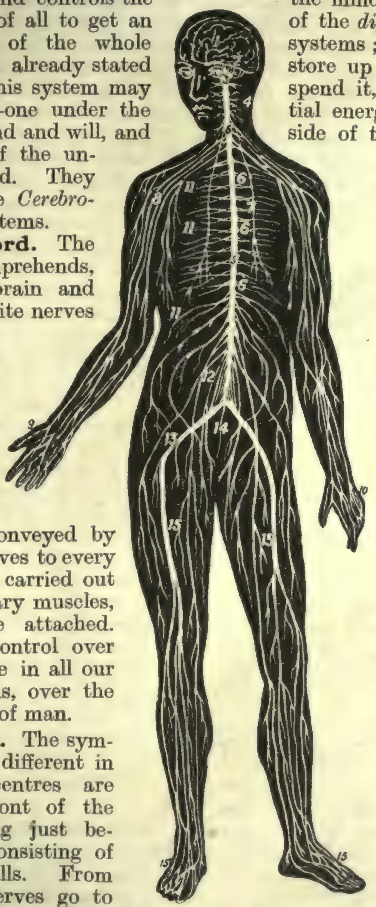
By Dr. A. T. SCHOFIELD

THE nerves are not mere expressions or ideas; they are actual threads or fibres, stretching all over the body just as the mass of telegraph and telephone wires run everywhere over London. They connect the "brain-centres" with every part of the organism, and along them impulses are incessantly travelling to and from the brain. In order to understand the machinery by which the mind controls the body, it is necessary first of all to get an idea of the arrangement of the whole nervous system. We have already stated in an earlier section that this system may be subdivided into two—one under the control of the conscious mind and will, and the other under the sway of the unconscious part of the mind. They are called, respectively, the *Cerebro-Spinal* and *Sympathetic* systems.

Brain and Spinal Cord. The cerebro-spinal system comprehends, as its name implies, the brain and spinal cord and all the white nerves connected with them. This complicated machine forms the executive of the government, which consists of the supreme controlling power of the conscious mind, and transmits its will to the whole body. All commands received by the brain from the mind are conveyed by the white cerebro-spinal nerves to every part of the body, and are carried out by the striped and voluntary muscles, to which the nerves are attached. This system has special control over the expenditure of life-force in all our actions and words—that is, over the animal life or *kinetic energy* of man.

Sympathetic System. The sympathetic system is entirely different in every particular. Its centres are situated all along the front of the spine, the chief one being just behind the stomach and consisting of a large mass of nerve-cells. From these centres small *pink* nerves go to all the organs of the body, to all the blood-vessels, and to many other parts. It is also closely connected with the lower part of the brain and the spinal cord.

This system acts and carries on its ceaseless and most complicated operations without the conscious mind having any power to interfere or even to discover what is going on. Its actions appear at first sight to be mainly mechanical, but a longer study shows they are all controlled and set in motion by a central purposive power for the good of the body; this power is the unconscious mind. Although the sympathetic system appears to carry on all the complicated processes of life on self-acting principles, they are really under the control of the mind, which thus directs the actions of the *digestive, circulatory*, and *respiratory* systems; in short, those that produce and store up life-force rather than those that spend it, or over the vegetative or potential energy rather than over the animal side of the life of man. The sympathetic nerves are connected with the smooth, unstriped muscles.



105. NERVES OF THE BODY

1. Cerebrum 2. Cerebellum 3. Medulla 4. Cervical nerves 5. Spinal cord 6. Dorsal nerves 7. Phrenic nerve 8. Brachial plexus 9. Nerves to the palmar surface of the hand 10. Nerves to the dorsal surface of the hand 11. Intercostal nerves 12. Lumbar plexus 13. Great sciatic nerve 14. Cauda Equina. 15. Nerves to the lower extremities

Cerebro-spinal Nerves. The cerebro-spinal nerves themselves [105] are, as I have said, the cords or electric wires that stretch from the brain and spinal cord to every part of the body. They are *white threads* of microscopic size collected into bundles or bands called nerve trunks, the largest being three-quarters of an inch broad in the thigh [106], and the smallest, almost invisible, like the finest thread. If we examine one of these nerve trunks we find it surrounded by a sheath of connective tissue, and consisting of bundles of smaller nerve bundles and blood-vessels and lymphatic fibres. In the nerve trunk these bundles are not twisted, but lie straight side by side. The bundles can be subdivided still further, until we get to the single *nerve fibre* [107].

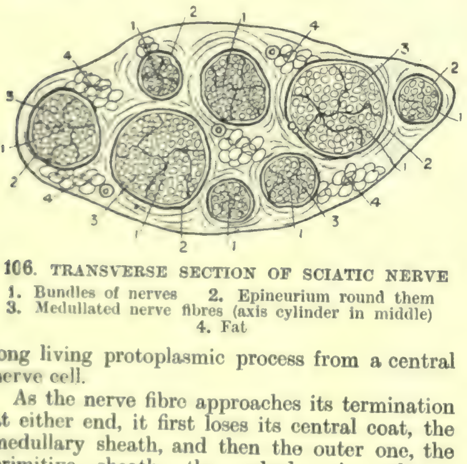
Every nerve fibre runs (just like a telephone wire) straight from its starting point to its end, and without branching or uniting with others. The trunks branch and divide and join, but the undivided fibres never do so during their course. One thirty-sixth part of the whole weight of the body is nerve substance.

Structure of a Cerebro-spinal Nerve. The medullated or cerebro-spinal nerves of which we speak vary in size from $\frac{1}{12000}$ to $\frac{1}{1500}$ of an inch, and consist of three parts.

First there is a protective sheath like the *hemp covering* of an underground electric wire; then a fine white substance sheathing the nerve all round, like the *sheath of guttapercha* which insulates (or prevents any of the electricity escaping from) the electric wire in the centre; and lastly not a *wire*, but a tube full of fluid, along which, it is believed, the impulse travels from the brain.

The outer covering [107] is called the primitive sheath or the *neurilemma*, and is a delicate membrane with constrictions every one-fifth of an inch and occasional corpuscles between. The sheathing or insulating substance is called the medullary sheath, medulla, or *white substance of Schwann;* it gives these nerves their white appearance, and it also affords rich food for the nerve within, on account of the large amount of fat it contains in an emulsion, the globules of which refract the light, and thus account for its colour. It is semi-fluid and like chyle.

The electric wire in the centre is called the *axis cylinder* [108], and is the essential part along which all impulses travel. It occupies a quarter of the diameter of the nerve, and in a cut specimen often projects like the wick of a candle. It is a tube of fluid enclosed in a delicate membrane, and is really an enormously



106. TRANSVERSE SECTION OF SCIATIC NERVE
1. Bundles of nerves 2. Epineurium round them
3. Medullated nerve fibres (axis cylinder in middle)
4. Fat

long living protoplasmic process from a central nerve cell.

As the nerve fibre approaches its termination at either end, it first loses its central coat, the medullary sheath, and then the outer one, the primitive sheath, the naked axis cylinder breaking up into fibres at its attachment.

Structure of a Sympathetic Nerve. In sympathetic nerves the non-medullated nerve fibres are also gathered up into trunks and bundles, and consist of axis cylinder and primitive sheath only; they vary in size from $\frac{1}{8000}$ to $\frac{1}{5000}$ of an inch. The absence of the medulla coat, the white substance of Schwann, gives these a greyish or pinkish colour.

These nerves differ further from the medullated in branching frequently and forming networks.

In the brain and spinal cord we get innumerable naked axis cylinders without any sheath at all. The cells from which these fibres spring occur generally in clusters called ganglia, and may be of any shape. They always have a nucleus, and have one or more branching processes or poles; hence they are called unipolar, bipolar, multipolar, or, if without bundles, apolar. One of these processes, which is probably prolonged into a nerve, is always unbranched, and is called the axis cylinder process.

These cells have no distinct limiting membrane, and consist of granular protoplasm with a large nucleus. They are often angular and triangular in shape, and able to move when living.

Four Kinds of Nerve Cells. We may recognise four varieties of these cells:

1. Those with no white substance of Schwann or covering of neurilemma, as in the brain, and connected with the naked axis cylinder nerves.

2. Those with no white substance of Schwann, but with neurilemma, as in the sympathetic ganglia, and connected with the non-medullated sympathetic nerves.

3. Those with the white substance of Schwann and no neurilemma, as in the brain, and connected with nerves of similar construction, which form the white substance of the brain.

4. Those with both the white substance and neurilemma, as in the ganglia of the spinal cord, connected with ordinary medullated nerves.

Where the Cells are Found. Nerve cells are found in the brain and spinal cord, in ganglia, and at nerve endings in the tissues. The spinal cells are generally unipolar, and are embedded in a finely granular ground substance (neuroglia), and have no neurilemma. In the ganglia of the posterior root of the spinal nerves the nerve cells have a sheath of neurilemma and a short process which branches like a T.

The function of these cells appears principally to consist in the nutrition they afford to the nerve. They may also increase the area of nerve action, and here also non-medullated nerves are often changed into medullated. There is very little evidence that these spinal root ganglion cells possess any automatic or reflex power. All such action appears to exist in the brain and spinal cord only.

Nerve matter has a specific gravity of 1,031. It is 70 to 80 parts water and 20 to 30 parts solids. The solids are composed as follows:

Phosphoric acid	9·0
Phosphate potash	55·0
Phosphate sodium	23·0
Phosphate iron	1·0
Phosphate calcium	2·0
Phosphate magnesium	3·0
Chloride sodium	5·0
Sulphate potash	1·5
Sulphate silica	·5
	100·0

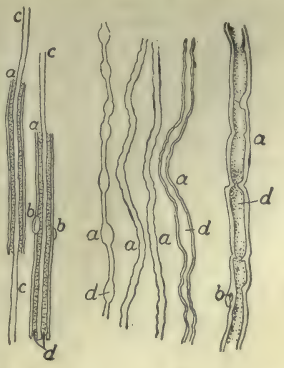
These elements are combined to form characteristic compounds, of which the chief are cerebrin, lecithin, and other substances. The very large proportion of phosphorus will be noted.

Nerves are not elastic and do not retract when cut, but they can be stretched without rupture.

We know little of the active life of nerves. It has not been proved that they absorb O and give out CO_2. They are very excitable, as can be shown in various ways.

Stimulation of Nerves. *Mechanical stimuli* produce at first either sensation or movement. If continued a long time the sensation gets lost and the movement ceases. When a leg

sleeps the temporary paralysis is believed to be due to the continued pressure of the under-knee into the hollow of the upper one, when the legs are crossed, so that the axis cylinder gets squeezed. Heat and cold stimulate a nerve, unless they are excessive, when they paralyse it. Chemicals also, such as acids, alkalies, alcohol, ether, chloroform, at first stimulate and then paralyse. Electrical stimuli act most on a nerve at the moment of application (making) or cessation (breaking). Single shocks rapidly applied so excite the motor nerves that tetanus is produced in the muscle. It is frequently found that the further a motor nerve is from the central system, and the nearer a sensory nerve is to it, the greater the effect produced by electrical stimulus.


A B

107. ISOLATED NERVE FIBRES

A. Two fresh nerve fibres
B. Nerve fibres, showing medullary sheath broken up

a. Neurilemma b. Nuclei c. Axis cylinder d. Medullary sheath, or white substance of Schwann

The nature of the *normal stimulus* is entirely unknown. It travels from or to the brain, giving rise to motion, or sensation, and moves more slowly than stimulus induced by electricity.

Nutrition of Nerves. The nutrition of nerves depends to a great extent on the nerve cells, and their excitability depends on their nutrition. Nerve fibre gets exhausted more slowly than muscular fibre, and recovers more slowly. Continued inaction of a nerve diminishes its excitability. If any nerve be severed, degeneration sets in, and the irritation decreases from the cut end upwards. Repair takes place when the severed ends are brought together from the sound parts in the reverse direction. The effects of cutting a spinal nerve are very instructive. (1) If the *whole nerve* be divided after the junction of the anterior and posterior roots, complete peripheral degeneration of both sensory and motor fibres sets in, the central part remaining unaltered. (2) If the *anterior root* alone be divided, only the motor peripheral fibres connected with it degenerate, the rest of the nerve remaining sound. (3) If the *posterior root* be divided before the ganglion, the nerve only perishes between the cut and the spinal cord. (4) If it be divided both before and after the ganglion, the degeneration spreads both ways. These experiments show that the centre of nutrition of anterior nerves lies in the spinal cord; of the posterior in the ganglion.

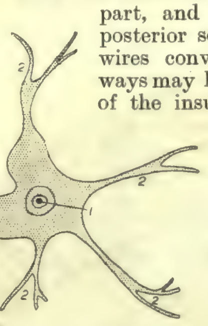
Electric Nerve Currents. There are small currents of natural electricity in healthy nerve tissue as in muscle. Natural nerve currents in sensory nerves travel about 140 ft., and in motor 111 ft., per second. Electricity and light travel about 200,000 miles per second. Sensory and motor nerves will conduct impulses indifferently either way. The direction of the current is determined by the source of the impulse, which in sensory nerves is peripheral; in motor, central.

As we have seen, the effect of stimulation of a nerve depends on the manner of its ending. Theoretically, a nerve can carry a current either way, but practically it can only be used in the body to convey a current in one direction, because of the nerve ending. The passing of a nerve current is therefore shown in an afferent or sensory nerve by pain or other sensation: in an efferent or motor nerve by muscular twitching or movement. Sensation is the result of organic change in a central nerve cell, just as movement is the result of organic change in a muscle cell. The terms sensory and motor are not, however, quite accurate.

Another Classification of Nerve Fibres. Nerve fibres are better divided into (1) afferent or centripetal; (2) efferent or centrifugal; and (3) intercentral—*i.e.*, between the two nerve cells.

Motor, or *efferent nerves* carry orders from the brain and spinal cord to all the muscles of the body. When it is remembered that each muscular fibre has a nerve attached to it, the great number of them is apparent. The longest nerve fibre is, of course, that which reaches from the brain to the big toe.

These nerves end in the muscular fibre in a sort of flat plate, which is fastened on to it; it has the power, by means of its current, of suddenly causing the fibre—and hence the whole muscle—to *shorten and thicken*. The nerves leave the brain and spinal cord from the front part, and run in bundles with the posterior sensory nerves. Thus, two wires conveying currents in opposite ways may lie side by side; but because of the insulating sheath the currents never mix. The nerves all commence or end in some brain cell in the grey matter.



108. NERVE CELL, SHOWING AXIS CYLINDER

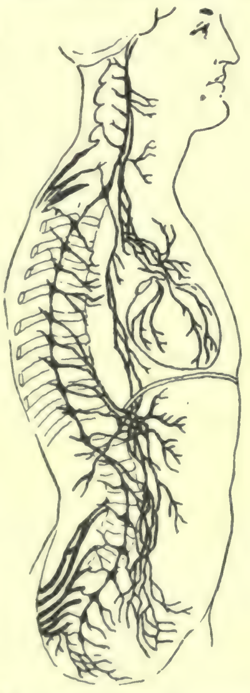
1. Nucleus 2. Branched processes 3. Unbranched process, forming axis cylinder of nerve

Sensory, or *afferent nerves* convey impressions from every part of the surface of the body, and from every part of its interior to the brain, making it acquainted exactly with all that is going on. Every single fibre of the countless millions starts from beneath the skin, or from some part or organ, and runs, joined with others in bundles, to the back of the brain or spinal cord, which it enters, and then terminates in one of the central nerve cells. These nerves convey all the intelligence to the brain of what goes on inside and outside the body. They convey sensations of heat

and cold, of pain and pleasure, of hardness and softness, smoothness and roughness, as well as sensations of taste and smell. In the ear and eye they are connected with elaborate instruments to convey light and sound.

Sympathetic Nervous System. We will now leave the cerebro-spinal system, and turn to that with which the conscious mind and will have nothing whatever to do—the *sympathetic nervous system* [**109**]. We have already seen that it lies all along the front of the backbone. It is also connected in very many parts with the spinal system, so that some of our actions are partly voluntary and partly sympathetic. Our mind can recall actions which make us blush for shame, but the blush itself is due to the enlargement of the capillaries by the sympathetic nerves.

The sympathetic nerves have, speaking generally, the same functions as the cerebro-spinal nerves, being both afferent and efferent. That they conduct afferent impressions, not generally felt as sensations, is clear in disease when we experience sensation in parts that are ordinarily without any feeling whatever, and are supplied by sympathetic nerves. Only intense impressions or sensations in disease are thus conducted on to the conscious brain. The sympathetic nerves are pink or grey, because they consist only of two parts, the outer fibrous coat and the inner tube of nerve matter. Many of the internal organs have sympathetic systems of their own. The heart has no less than three sympathetic nerve centres in it, in virtue of which it beats, and can go on beating, even when removed from the body, for many hours if fed with blood and kept warm. The beating is, however, controlled in two ways—from the medulla, by means of the pneumogastric nerve that slows it; and from the main sympathetic system, by a nerve that accelerates it. Hence, in indigestion, etc., when the sympathetic nerve is irritated, the heart's beat is quickened, and it palpitates or beats very fast; whereas, if the nerve in the neck be compressed or irritated, the heart is slowed, and might be stopped altogether. Although it has been broadly stated that the cerebro-spinal system controls the *actions of life*, and the sympathetic system the *processes of life*, yet it must be understood that the fibres of both often intermingle, and it is frequently impossible absolutely to distinguish the one from the other. As a general rule, however, the above distinction holds good, and it is most valuable.



109. THE SYMPATHETIC SYSTEM, SHOWING SPINAL AND SOLAR PLEXUSES

Nerves Given Off by the Brain. Nerves are arranged in pairs, right and left, all over the body—that is, there are always two alike. The brain itself gives off twelve pairs of nerves, as follows:

One pair of sensory nerves from the nose, conveying smell.

One pair of sensory nerves from the eye, conveying light.

One pair of sensory nerves from the ears, conveying hearing.

One pair of sensory nerves from the tongue, conveying taste.

One pair of sensory nerves from the face and teeth, principally conveying feeling.

Three pairs of motor nerves, giving movement to the eye-balls.

One pair of motor nerves, giving movement to the face.

One pair of motor nerves, giving movement to the tongue.

One pair of motor nerves, giving movement to the neck; and

One pair of motor and sensory nerves running to the larynx, lungs, heart, stomach, and liver, and hence called the *pneumogastric* or the lung and stomach nerves.

Large nerves supply the arms with motion and sensation. They leave the spinal cord in the neck, and, passing out between the vertebræ, unite in a large cord that runs under the collar-bone, and there divides into five large nerves. One of these five can be felt at the inside and back of the elbow, where it is called the funny-bone. and can be rolled about under the finger. It gives sensation to the little and ring fingers, and when it is rolled about a pricking sensation is felt in these.

All down the back a pair of nerves is given off from the spinal cord about every inch, and runs along inside each pair of ribs. Lower down in the abdomen they run in the muscular wall. At the base of the spine two great cords are given off; these soon divide again, one on each side, one for the back and the other for the front of each leg. The posterior nerve is called the sciatic, and when it is inflamed we are said to have sciatica, which is very painful.

The nerves, like the blood-vessels, are well protected from violence by running along the inside or least exposed parts of the limbs.

Continued

JUDGMENT IN ALL THINGS

The Necessity for Criticism and Selection. The Intellectual Conscience. Value of Reason in Daily Life. Testing Opinions by the Highest Standards

Continued from page 1881

By HAROLD BEGBIE

TO have a right judgment in all things is one of humanity's oldest aspirations. No man, in whatsoever field of activity he exercises his energies, can dispense with this faculty of judgment. The horsedealer as well as the picture-dealer, the tradesman as well as the artist, must know how to criticise before he can hope to succeed in his enterprises. Criticism is not, as too many people suppose, a petulant finding fault, but rather is it that practical and utilitarian "art of judging of and defining the qualities or merits of a thing."

And yet, important as is this faculty in the practical affairs of life, the art of criticism remains untaught in our schools. No one is instructed how to discriminate between good and bad literature, between true and false art, between wisdom and folly. The schoolboy is supposed to emerge at the end of his studies a wise and prudent man, able to choose the good and discard the evil. And yet the most casual reflection must show us that only the closest and most watchful studies can produce a discriminating mind.

The Intellectual Conscience. It is the object of this article to indicate the easiest manner for acquiring that sensitiveness of intelligence which ends in the creation of the intellectual conscience. We may perceive from the fact that it is not the profound theologian whose faith is shattered by a sixpenny reprint of one of Haeckel's ventures into philosophy, nor the consummate painter who breaks into rhapsodies at the latest picture-poster blazing from street hoardings, that a wide culture is the best means for acquiring sensitiveness of intelligence. The more extended a man's reading, the deeper is his reflection, and the more thorough and profound his experiences, the less likely is his mind to be the sport of every changing fashion and every sudden enthusiasm in the sphere of the intellect. It is, therefore, before all things, necessary for a man to study and to reflect before he can trust his judgment. The intellectual conscience, indeed, may be said to hang as one of the first fruits on the tree of knowledge.

But since it is a platitude that no man can complete in a single life his search after wisdom, it is apparent that there must be some method of acquiring sensitiveness of intelligence as the student pursues his journey. Indeed, it is essential that this should be the case, for without such running acquisition of sensitiveness the student would be for ever selecting wrong models and following false masters. Let us, then, endeavour to discover in what fashion the student may possess himself of an intellectual conscience before he has graduated in knowledge and become a scholar.

The A B C of Criticism. In the smallest and most common acts of life a man may set himself to learn the art of criticism. He will find it possible to begin this education at every step and turn of his everyday life—nay, he will find it impossible to avoid it. For directly a man has seen that it is good to ask himself why he admires or condemns a thing before deciding about it, he has learned the alphabet of criticism, and for ever after, in some fashion, is a critic. This is the beginning of the gospel of criticism: *not* "do I like such a book or do I detest such a picture?" but "*why* do I like, and *why* do I detest?"

It is a common experience to find people expressing opinions and passing judgments who confess, on being questioned, that they have no reason for their faith. They accept without question the dictates of some instinct in their mind, and are not in the least perturbed to be told that this opinion of theirs is in sharpest opposition to the uttered judgment of many centuries. Never once have they asked themselves what are the qualities they admire or dislike in the work about which they are ready to express so fluent and decided an opinion.

Now, a man without scholarship cannot ever pass a satisfactory judgment upon a work of art—to do that necessitates acquaintance with the best that has been said and written on the whole subject; but he can at least give to himself reasons for his own sensations concerning the particular thing, and this he must accustom himself to do if he would create an intellectual conscience. He must learn to suspect his first impressions, to be chary of listening to his dumb predilections; he must examine and cross-examine himself till he has good and substantial reasons for his judgment. Even in buying a newspaper, let a man ask himself why it is that he prefers this particular paper to the others lying on the bookstall. In selecting cloth for a suit of clothes, or carpets for his house, let him question himself as to why he chooses such a pattern or rejects such a fabric. Let him always be intelligent, logically intelligent, in exercising his power of will.

Creating a Free Will. That great artist G. F. Watts once lamented to the present writer that men and women more and more asked themselves if a thing were fashionable, and not if it were true or beautiful—blindly following a prejudice, and never educating in themselves their own faculty of selection. Criticism, be it particularly remembered, does not concern art and literature alone—it concerns

nature, it concerns life, it concerns the destiny of the soul. To pass through existence without having consciously used the faculty of selection is to miss one of the first educative forces of human experience. We are largely what our opinions make us, and not to have opinions is not to exist as an intelligible being. On the other hand, to concentrate the mind upon the exercise of the critical faculty is to find oneself treading that shining path of life made luminous by the brightness of the greatest human souls. By such exercise we call into being the highest and the most helpful faculties of intelligence, and establish in ourselves that oft-debated but rare possession of humanity—a free will. Instead of being dumb and driven cattle, we become separate and distinctive personalities. For a man who cannot give himself reasons for the creeds that he holds, the opinions he advances, and the course of action he pursues, is not a distinct and individual personality—he is merely the pallid shadow of a million inarticulate lives.

Test Opinions by Noble Standards. This is the great value of learning the art of criticism—it intensifies personality. The man who accepts blindly the machinery of his period is never likely to be a great inventor. The man who unquestioningly accepts the commercial methods of his fathers is never likely to make a future. But he who studies the existing order of things with the conviction that there is no finality in human progress, with a certain dissatisfaction of mind in the progress of the present time, is he who will find himself presently discovering new avenues of advance, and perceiving in the mists of the future new and more delectable goals for human seeking.

But the highest form of criticism lies in testing opinions by the noblest standards. If we are asked to exalt a sailor to the heavens, we must first compare him with Nelson. If we are asked to salute a poet as the brightest of stars, we must first compare him with Shakespeare. Or, if we are asked to praise the ethics of a moral teacher, we must compare him with Plato, Aristotle, or Marcus Aurelius. We must never be carried away by the heady excitement of a moment, or by the generous enthusiasm of a sudden fashion. Always we must have in our possession some definite and articulate opinions concerning what is the noblest poetry, the greatest seamanship, the sublimest philosophy. We must know *why* we prefer Wordsworth to Martin Tupper, Cervantes to Hawley Smart, and Leonardo da Vinci to Phil May.

A Persuasive Reason. Once reflected upon, the serious student of life will perceive that loyalty to the intellectual conscience is one of the first duties of the soul. The intellectual conscience will appear to him as greatly sacrosanct as the moral conscience. He will be honest with it. He will permit of no shuffling with it. He will accept no dictation from priest or journalist, will not be swayed by the intolerance of parents nor by the prejudice of schoolmasters. At the bar of his own reason he will arraign every question calling for judgment, and only by the arguments of his intellectual conscience will his decision be influenced. He will perceive more and more that by the exercise of his judgment his character is formed, his individuality is developed; and he will gradually come to see that an increasing nicety of discrimination is the main progress of life. Every man who has learned to withhold admiration from meretricious art or false literature is stronger to conquer in himself faults of disposition and evils of character. By having always a persuasive reason for what we do and think, we grow further from our animal ancestry and approach nearer to our divine destiny.

Education and Personality. The full value of cultivating the art of criticism side by side with study may be seen in the sameness of effect produced upon boys' minds by public schools and universities. Education is here witnessed producing a pattern, manufacturing and perpetuating a type. Instead of developing individuality and increasing the forces of personality, our popular system of education tends rather to suppress individuality and to paralyse personality. It should, obviously, be the function of education to draw out, intensify, and fortify the separate and distinct personality of every student, since flexibility of intellect and originality of ideas are indispensable qualities in a great people. Therefore, it is of high importance that the claims of criticism should be urged by reformers of education. Criticism ought to be taught, if not directly, in any case indirectly, in every class and during every study. Boys ought to learn, as soon as they can use their wits, to be able to say why they give particular answers to the questions of their schoolmasters.

Criticism in Daily Life. But for every man the art is to be cultivated in his everyday life, and all his learning is to be applied to this end. He may neglect it, he may decide to trust his instincts, he may ridicule the idea that he should bother himself in these rushing times with reasons for his every action and opinion; but without some application of criticism to his daily life it is impossible for him to succeed in his undertakings, and certainly without it he cannot rank himself with reasoning creatures, with the innovators, inventors, and discoverers who are the advance-guard of humanity.

Finally, a critical mind is not a pessimistic mind, and must on no account be confused with the spirit of pessimism. The critical mind can admire generously and praise encouragingly; but it refuses to admire without discrimination or to eulogise without reason. Moreover, it refuses to perceive final perfection in any achievement of humanity. The architect criticises buildings in order to build better; the surgeon criticises an operation in order to save life with greater certainty. Always a student, always conscious of the sanctity of his intellectual conscience, the educated man holds a balance, and is always able to express with perfect lucidity the reason for the faith that is in him.

Continued

BRICKLAYING MATERIALS

Various Forms and Qualities of Bricks. Cutting and Rubbing Bricks. Varieties of Brickwork. Composition and Mixing of Mortars. Gauged Work

Continued from page 1863

By Professor R. ELSEY SMITH

THE manufacture of bricks has been described, but it must be understood that the qualities of brick produced by burning show very great variations, depending largely not only on the nature of the earth from which the brick is made, but also on the manner of moulding and burning them. As a rule, bricks burnt in a clamp show greater differences between the best and worst brick produced than do those burnt in a kiln.

Bricks moulded in a plastic state are more liable to damage after moulding than those moulded dry. The manufacture of the latter requires very powerful machinery, and such bricks are, as a rule, denser, heavier, stronger, and have truer and more uniform edges than those moulded when plastic; they also exhibit a much smaller range in quality and colour.

Malm Bricks. *Malm* bricks burnt in a clamp will result in bricks practically perfect in shape and of an even texture and colour. Such are known as *cutters.* They stand at the top of the scale of quality, and are used for *rubbed and gauged work* [20 and 22]. The next quality is known as *seconds;* they are suitable for the best facing work. *Shippers* are bricks well burnt and hard, but not of perfect shape. They derive their name from having been largely exported in ships as ballast.

Stocks. *Stocks* are also sound and hard, but inferior in form; the majority of bricks in a clamp are of this quality, and are in common use for all ordinary work. Where the outer face of brickwork is required to present a particularly good appearance, free from any great irregularities in colour, the bricks used to form the surface should be picked out from the general mass for evenness of colour and good form, or seconds may be employed for very good face work. All the above classes of bricks, some of which have further subdivisions, are sound and reliable, and are classed according to the regularity of their form and evenness of colour when burnt. They are available for all classes of ordinary building and for either external or internal walls. The prevailing colour is a bright, rich yellow.

Inferior Bricks. The remaining bricks to be described are of a distinctly inferior quality, and their use is restricted to internal walls in inferior work. *Grizzles* are bricks to which air has had access during burning, and are of a greyish colour. *Place bricks* are bricks which are not thoroughly burnt and the surface of which is not vitrified; they are porous, weak, and usually of a pinkish colour. *Chuffs* are bricks that have been acted upon by rain during burning, or have not been efficiently dried; they are soft, and liable to disintegrate, and their employment should be prohibited. *Burrs* are masses of brick which have become fused together during burning; they are found generally near the live holes, where the heat of the clamp is excessive; they are unsuited for ordinary building operations, but are employed in rockeries, or they may be broken up for use in concrete.

Machine-moulded Bricks. The majority of machine-moulded bricks are burnt in kilns, and the quality of bricks produced at each burning is much more nearly uniform than in the case of clamps; but there are very many varieties in this class of bricks produced, due in a large measure to the chemical composition of the clays of which they are composed, and to variations in manufacturing processes. The local varieties are very numerous. Some of the bricks in most general use are the following.

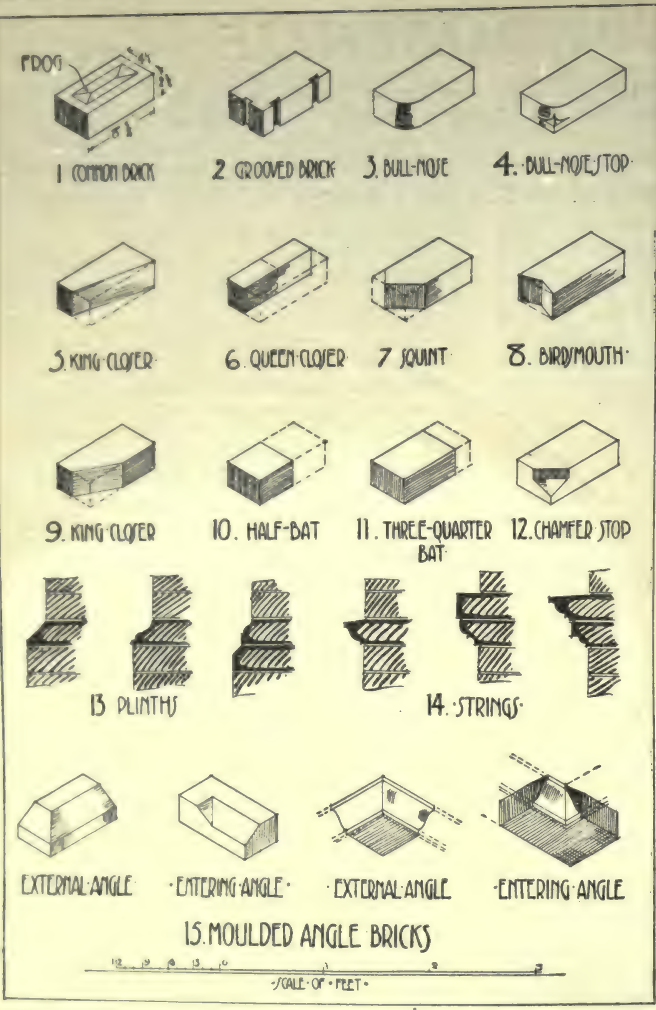
Gault bricks are burnt from the Gault clays in kilns; the best are hard and white, and are usually perforated with circular holes, running vertically through the brick with a view to reducing their weight.

Suffolk bricks are a variety of Gault brick of a very pale yellow colour, and are known as white bricks; they are dense and heavy, and expensive, and are often used for facings.

Fareham bricks are of a bright red colour varying in tone, and are much used as a facing brick, and the best qualities of them for rubbers.

Flettons are bricks made in the Midlands. They are very heavy, dense, and true to form, and work constructed with them will carry heavy loads. They are not of a very good colour, and the surface of the brick is smooth. For walls that are to be plastered these bricks are sometimes moulded with dovetailed grooves [2] to give a better key for the plaster than the smooth brick surface affords. For internal walls left unplastered they offer a very true and even surface for the application of distemper or whitewash; they are sometimes marked with bands nearly black in colour, due to variation in burning.

Staffordshire Bricks. *Staffordshire* bricks are made from a very dense clay; they are extremely hard, dense, almost non-porous, and of a very dark blue colour, verging sometimes on black. They will carry very great loads, and are used for brick piers carrying concentrated weights, and for railway and other engineering work; the surface will also stand much wear, and they are often employed, where their colour is not an objection, in the walls of passages and gateways subject to much traffic. Being non-porous, they are also much used for copings to walls, and in the form of paving bricks for yards and stables, and for such purposes are moulded in a great variety of forms.



Clinkers. *Clinkers* are small, hard bricks burnt at a high temperature, with a smooth, vitrified surface. For paving, the edges are generally chamfered, forming a V-shaped joint when laid; they are also employed in forming kerbs and channelling.

Fire-bricks. *Fire-bricks* offer great resistance to heat, and are used for setting stoves and boilers, and in any position where such qualities are required. The Dinas fire-brick, which is extremely refractory, may be used for lining regenerative furnaces, and in other situations where exposed to intense heat.

Glazed Bricks. *Salt glazed* bricks have the surface covered with a thin transparent glaze, caused by introducing salt into the kiln during burning, the sodium combining with silica in the clay to produce the glazed surface.

Glazed or enamelled bricks have the surface covered with an opaque glaze or enamel, either white or of various colours; such bricks cannot be easily cut or rubbed and are made in a variety of forms for special positions. The glaze is produced by dipping the brick into a *slip* formed of finely-worked superior clay, with which the colouring material is incorporated, and then burning in a kiln. It is more liable to chip than salt glazing, and is more costly.

Qualities of Good Bricks. It is not possible to supply an exhaustive list of the various bricks manufactured, but after a little experience of well-known types of brick it should not be difficult to determine, in most cases, if any given class of brick is likely to be reliable. The following characteristics should be sought for in any class of bricks to be used in building.

SIZE. This should be uniform. If bricks vary much in size, very uneven work results. The bricks used in London average about 8·75 in. by 4·25 in. by 2·75 in. [1], but many classes of bricks are considerably larger, and some are made smaller.

SHAPE. The faces should be square, and the arrises fairly true and not twisted.

ABSORPTION. This should not be excessive, and should not exceed 20 per cent. A brick should not absorb water very readily, but should give it off freely. An ordinary brick will often absorb about one-sixth of its weight of water, but a highly vitrified one not more than one-fifteenth, and some even less. Absorption may be tested by weighing a brick when thoroughly dry, completely immersing it in water till saturated, and then re-weighing it after any surface water has been drained off. The difference in the weights represents the amount of water absorbed. The tendency to absorb water readily or reluctantly may be tested by standing a brick half-immersed in water, and noting to what extent the water is absorbed by the upper half.

UNIFORMITY IN BURNING. This can be observed when a brick is broken across; the colour in section will often differ from the colour of the face, but even burning should result in a uniform character and texture, and should show slight vitrification. The brick, when broken, should be free from cracks and other flaws, and from stones.

RING. A well-burnt brick struck against another, or with a bricklayer's trowel, should give a sharp metallic ring.

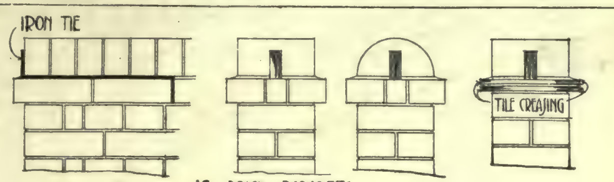
COLOUR. Where bricks are to be used in the face of a wall, the colour is of importance, but is entirely a matter of taste. For any work, the

colour having been selected, samples of bricks should be approved and labelled, showing the extreme limit of variation in colour or shade from the standard sample that will be accepted. It may be noted here that the general character of the colour of any piece of brickwork is materially affected by the colour of the mortar used in pointing the joints.

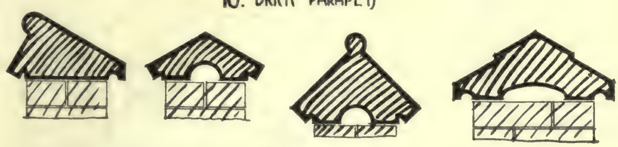
Judging Bricks by Appearance. The appearance of the brick will, as a rule, indicate the process by which it has been moulded. *Hand-moulded* bricks have a *frog* [1] on one side; the edges are, as a rule, not quite uniform or even, and the surfaces are somewhat rough. *Wire-cut* bricks are without frogs, and the top and bottom beds generally exhibit traces of the dragging action of the wires by which they have been cut. *Machine-moulded* bricks have sharp clean arrises, smooth surfaces, sharply-marked frog, with a trade-mark or maker's name, and sometimes a frog on both sides. Some kiln-burnt bricks are marked with dark bars, caused by the method of stacking the bricks in layers or rows at short distances apart, these bars representing the parts that have been in actual contact.

Special Bricks. Special forms of bricks are sometimes required in addition to the bricks of ordinary dimensions which have been described. It is possible to make bricks of any desired pattern and size within certain limits. Many manufacturers keep stocks of various moulds for special bricks, from which bricks can be supplied with due notice. Special shapes of bricks in frequent use are often stocked. It is also possible to have bricks specially moulded to suit any required situation, but their manufacture involves delay and some extra expense; where a large quantity of bricks of any particular form are required, it proves, however, more economical and satisfactory than cutting bricks to the required form. This is especially the case with glazed bricks. For certain work, especially that with delicate mouldings, rubbing gives much more satisfactory results than moulding. Of stock forms of bricks, the varieties that can be readily obtained, as a rule, are *splits*, bricks of ordinary length and breadth, but of less thickness. *Splayed bricks* [13] are those having a chamfer worked on one edge, made with splays of various sizes. *Bullnose* bricks [3 and 4] are those having one angle rounded or circular, on plan, the circle being usually struck with a 2¼ in. radius. Double bullnose bricks are also made, having two rounded angles. *Stops* [4, 12] for bullnoses and splays are made in various shapes when the surface is required to be brought back to a rectangular form. *Angle*, or *mitred bricks* [15] for dealing with such forms at angles, are also made, and are more satisfactory than cutting the bricks to mitre.

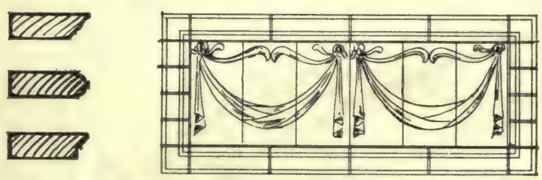
Moulded bricks for *plinths* [13], *strings* [14], *sills* [22], *moulded ribs* [18], *cornices* [19], *copings* [17], mouldings for *window jambs* [22], *sunk panels* [18], and similar purposes, are made in great variety. Different manufacturers make and stock different sections, and some makers include plain and enriched bricks of *voussoir* [21] shape for arches of different radii, including enriched voussoirs. All such bricks are carefully arranged to bond with ordinary brickwork, and include, as a rule, all returns, mitres, stops, etc., that are usually required.



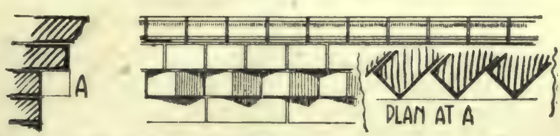
16. BRICK PARAPETS



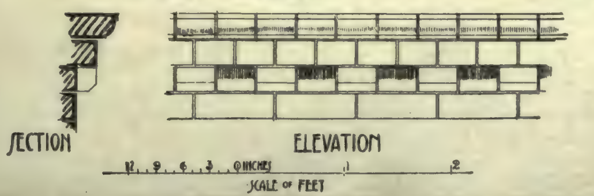
17. MOULDED COPINGS



18. RIB & PANEL MOULDINGS & ENRICHMENTS



19. BRICK CORNICES



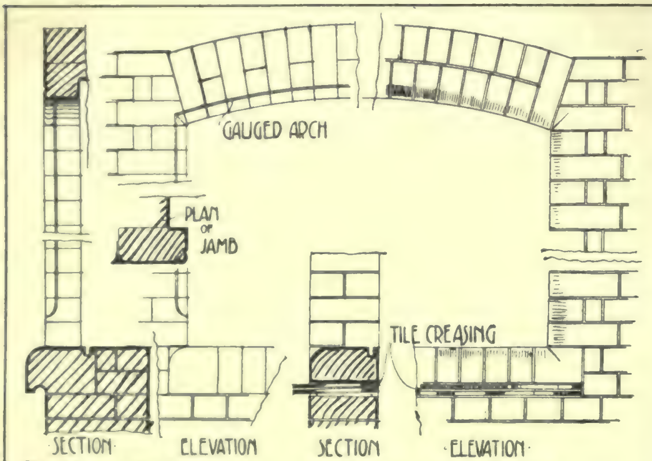
Enrichments [18] of various forms, including panels, may be moulded in brick earth and burnt, and an inexpensive form of enrichment is thus obtained, but it is inferior in effect to good carved brickwork.

Gauged Work [20 and 22] is a term applied to brickwork for which the bricks are cut or rubbed to exact sizes. When the bricks are cut the term *axed* work is used, and this treatment is employed when the bricks are of a hard texture and very fine close joints are not required. When the bricks are rubbed the work is described as *rubbed* and *gauged*. These bricks are used for the highest class of work, and are set with a very fine true putty joint, to be described later.

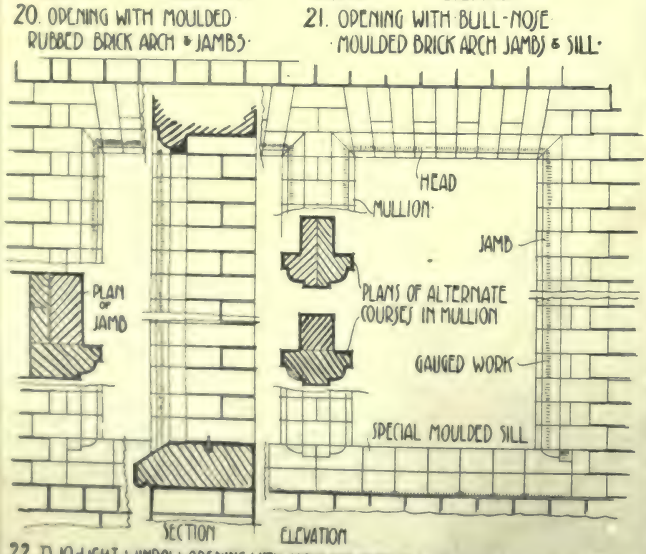
Axed Work. The tools used in axed work are the *tin saw* [24], with which, after the outline is marked, the required shape is cut in for about ⅛ in.; the *bolster* [25], a short broad chisel; and a *club hammer* [26], by means of which the superfluous brick is knocked off; a *chopping block* [30], consisting of two blocks of wood secured to a base, so as to form an angle in which the brick can be placed for cutting; a bricklayer's *axe*, or *scutch* [27], consisting of a stock in which a blade about 1 in. broad and sharpened at both ends is fixed by means of a wedge.

A template of the exact size to which the brick is to be cut is prepared and placed on the external face of the brick—that is, usually, of course, the narrow, not the broader, surface of the brick—and the outline is marked on the brick and cut in with a tin saw. The position of the cuts are squared across with a *square* [35] at the ends, and the back is similarly marked and cut; the superfluous brick is then knocked off with the bolster and hammer, the brick is placed in the chopping block, and the axe or scutch used to smooth the sides, which must be carefully done, so as to ensure that they are true and do not project. The object of using the tin saw to cut in the outline is to ensure a clean, sharp arris. This class of work is chiefly used for shaping the bricks to be used in segmental and flat arches. Cutting mouldings is costly, and when required to be introduced where hard facing bricks are used, purpose or stock-moulded bricks are generally employed.

Rubbed and Gauged Work. For rubbed and gauged work the bricks employed are the rubbers already described, which are somewhat soft, and are made extra large, so that when rubbed to the required gauge and set with a fine putty joint they will bond with ordinary bricks set in mortar. Different tools are used for producing this work. The *saw* [28] consists of a frame-saw, and the blade is formed of two wires of soft steel or malleable iron twisted together and strained. This is used for cutting the bricks to the required shape. The *rubbing stone* [36] is a slab of York stone, gritty, and usually circular, and some smaller pieces of stone are required for finishing small surfaces, and flat and circular files are also employed. A *surfacing table* [37], or slab, is required, on which the worked bricks can be set up to test the accuracy of their cutting. *Moulds* [31] are also required in which the brick can be cut. These are formed of



20. OPENING WITH MOULDED RUBBED BRICK ARCH & JAMBS. 21. OPENING WITH BULL-NOSE MOULDED BRICK ARCH JAMBS & SILL.

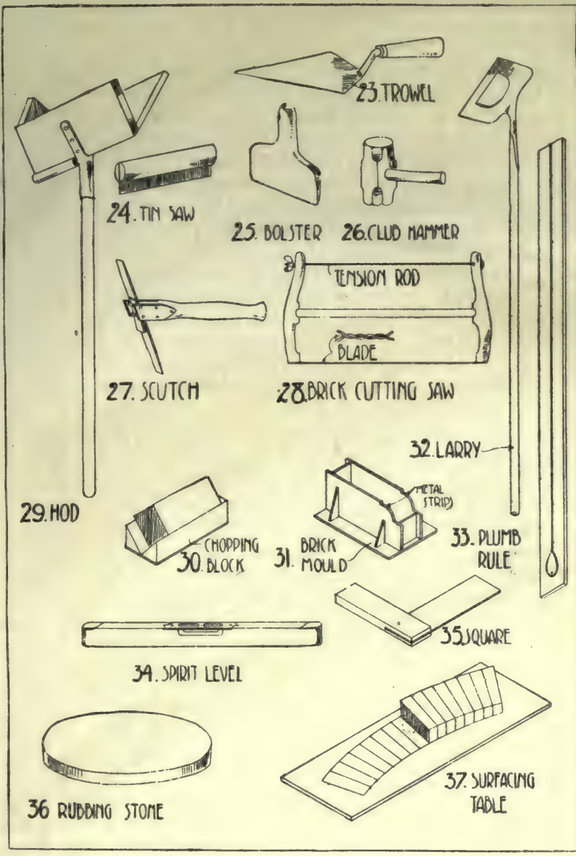


22 TWO-LIGHT WINDOW-OPENING WITH MOULDED RUBBED BRICK JAMBS HEAD & MULLION.

wood, and consist of a base and of two sides cut to the profile of the required brick, but a little full. They are stiffened with brackets, and the upper surfaces covered with strips of zinc, so that they are protected from damage when the saw-blade works over them.

This class of work is used for plain walling, which is the simplest work, and for straight mouldings; also for circular work, either plain or moulded, and for what is known as *circle on circle* work, in which a double curvature occurs.

In working a brick for plain work a beginning is made with one broad surface. This is rubbed on the rubbing stone with a sweeping motion till perfectly true; next one edge is similarly worked, so that it is perfectly true, and is tested with a square to ensure that it is at right angles to the face first finished. It is then placed in a mould of the size required to give it the necessary thickness, tightly wedged, and the upper part is removed with a saw; and by the use of similar moulds the width and length may also be reduced to exact dimensions, and the sawn surfaces are afterwards rubbed or finished with a hand-stone or file. For moulded work, or for circular work, the wood moulds are prepared of the necessary form, and the process is similar though not quite so simple.



Rough Cutting. We have now considered the manufacture of various forms of brick, most of which the bricklayer is able to lay just as they are delivered on the scaffold, and we have also described the careful preparation of bricks for special situations by different processes, which are all covered by the general term *fair-cutting*. Such bricks are not prepared on the scaffold by the bricklayer, but in a shed, and are sent to the scaffold ready for fixing.

For many situations, however, some cutting on the scaffold is necessary, and this is generally termed *rough cutting*. It includes the rough shaping of bricks by the bricklayer's trowel to suit special positions, the cutting off of angles of brickwork with a hammer and chisel before plastering, and the cutting of perforations and chases, and generally such work as does not involve forming a carefully finished face to the cut surface.

Uniting Brick to Brick. All walls or other structures built up of a number of blocks of materials of moderate size compared to the total mass, require that some means be taken to secure the combination of the component parts into a solid structure. In very favourable circumstances, where the individual blocks are comparatively large and finely wrought, friction by itself may suffice, as in some of the old Greek buildings. But, even when such materials were used, ties of bronze were largely utilised for uniting adjacent blocks and courses. Such work involves much labour in preparing the stones with true beds and joints, and in fitting in the ties.

Where the blocks are comparatively small, such a system is not practicable, and the usual practice has been, and still is, to fit them together with the help of some material that will bind them together. There is this further advantage in the use of such material, that it is not necessary to prepare the beds and joints with the same scrupulous care as when they are to come into actual contact, when perfectly true beds are required to secure an even bearing. The materials in general use for this purpose are all of them applied in a soft condition, and allow for slight irregularities in the adjacent surfaces, and the extent to which such irregularities exist will determine the thickness of the material used in the joint. For example, when bricks are used as delivered on a building, if they are placed one upon the other it will be noted that any two surfaces, as a rule, are not in contact all over, and in practice it is usual to form a bed or joint of about ¼ in. thick. If, for any reason, a very fine joint be required, the bricks have to be prepared by rubbing the adjacent surfaces till they are quite true. Much the same is true of stone walling. If small stones be used with rough

surfaces, thick joints are necessary, and if a fine joint be required, the surfaces must be carefully prepared.

Mortar for Brickwork. The material used for forming these joints between the hard blocks of material is usually described as *mortar* or *putty*. Bitumen has been employed in countries where it is found, but is not a cementing material in ordinary use. Mortar varies considerably in its nature and properties, according to the ingredients of which it is composed. The word usually implies a material composed of a fine *aggregate* [see page 332], such as sand, and of some form of lime as a *matrix* [see page 332]. *Cement mortar*, often referred to briefly as *cement*, consists of a similar aggregate mixed with Portland cement, or some other cement. It is a material similar to concrete, but requires a very much finer aggregate.

Mortar Aggregate. The aggregate for mortar is usually *sand*, which may be pit sand or river sand, and is required to be clean, sharp, free from all animal and vegetable impurities, and from loam or salt. If necessary, it must be washed, as described for use in CONCRETE [page 334]. If the sand be mixed with gravel or stones, it may be screened. This is done by erecting near the heap an oblong frame of wood, filled in with a series of stout wires running vertically. For ordinary mortar, these are usually ⅛ in. diameter, with three wires and three spaces to 1 in.; stronger horizontal wires occur at short intervals. The frame is fixed in an inclined position; the material to be screened is taken from the heap in a shovel and thrown against the face of the screen; the finer particles, forming sand, pass between the wires and fall behind the screen; the larger particles and stones run down the face of the screen, and are reserved for concrete.

Various substitutes may be employed if sand cannot be obtained, or may be used as a portion of the aggregate, provided the particles are sharp, clean, and durable. The most usual substitutes are crushed sandstone, crushed pottery, or crushed brick, but the bricks for such purposes must be thoroughly burnt, hard, and vitrified, and, if old bricks are used, should be cleansed of any old plaster adhering to them. Fine ashes often make a very satisfactory mortar, but give it a dark colour.

Qualities in Mortar Aggregates. Whatever the aggregate employed, it must be clean; particularly it must be free from salt, which would cause dampness and efflorescence in the mortar, and from loam or clay, which would prevent the matrix adhering to the particles. The presence of loam may be detected by rubbing a small quantity in the fingers when it is damp. If loam be present, the clay will be rubbed off, and remain as a slightly sticky yellowish substance on the fingers. The only means of getting rid of such matter is by washing as already described.

The sharpness, which is also essential, may be detected by employing a magnifying glass, when the grains should appear irregular and angular, not rounded and smooth. Sharp sand, if rubbed between the fingers close to the ear, will give a sharp grating sound.

Quality of Lime for Mortar. The matrix selected depends largely upon the purpose for which the mortar is required, and the strength expected in the walling. A pure or fat lime should never be used in making mortar, except for temporary work, where no strength is required; such lime can set only by the absorption of carbonic acid from the air, which never reaches the inner portions of a bed of mortar, and in consequence this never sets. A feebly hydraulic lime, such as the greystone lime burnt in the neighbourhood of Halling, Dorking, or Maidstone, may be used for ordinary building work in which no great strength is required to be developed, but is not suitable for footings in damp situations. Blue lias lime, which possesses considerably higher hydraulicity, is used for building of a good class, and may be utilised even for foundations in damp situations. The most eminently hydraulic are Aberthaw and Halkin Mountain lime, but where an eminently hydraulic material, or one possessing great strength is required, Portland cement is usually specified. Other cements, such as Roman, are confined, as a rule, to rendering or covering walls externally.

Composition of Mortar. The sand in mortar is employed partly for reasons of economy; it also serves to lengthen the time within which setting takes place, and renders the material easier to use; but it diminishes the strength of the resulting mortar, and the proportion in which it is employed is, therefore, regulated by these considerations. The proportions of aggregate and matrix usually employed are the following:

1 part of feebly hydraulic lime, 2–3 parts aggregate; 1 part eminently hydraulic lime, 3–4 parts aggregate; 1 part Portland cement, 2–3 parts aggregate.

Portland cement is usually mixed with a comparatively small proportion of aggregate. Its strength is greatly reduced if a large proportion of aggregate be employed, and as cement is, as a rule, employed mainly where considerable strength is essential, it is important that it should not be seriously impaired.

Experiments by Grant showed the results given in the following table:

1 part P.C.	+1 part sand	= 75	per cent. of neat Portland cement.
1 ,,	+2 ,, ,,	= 50	,, ,, ,,
1 ,,	+3 ,, ,,	= 33	,, ,, ,,
1 ,,	+4 ,, ,,	= 25	,, ,, ,,
1 ,,	+5 ,, ,,	= 17	,, ,, ,,

They also demonstrated that it takes a much longer time for the cement mortar to attain its ultimate strength when a large proportion of aggregate is employed.

The methods of slaking limes and cements for using in mortar have already been described, and the nature of the setting, but the method of mixing may be briefly referred to.

The Mixing of Mortar. Much will depend on the amount of mortar required daily. If this be small the mixing will be done by hand,

but in large works a mortar mill is often used. In the case of a mortar which sets slowly there is no great harm in mixing up more mortar than can be used in a single day; but in the case of mortars made with eminently hydraulic limes and cements this must on no account be allowed. Where a quick-setting cement is mixed with a small amount of sand, it must be made fresh and used up before setting begins. In any case, mortar cement that has once set should not be allowed to be "knocked up again"—that is, mixed with a further supply of water till it is soft and then employed as mortar. This is a practice that is often indulged in and even supported, but should not be allowed, for such mortar or cement may reset, but it will never attain the strength that freshly-made mortar would do.

Working up by Hand. In working up by hand it is usual, if the lime be in lump, to measure out the amount of sand and lime required, to form a roughly circular ring of the sand, or other aggregate, to place the lime within it, to sprinkle it with water, and to leave it till slaking has taken place. When this is complete more water is added, the sand from the ring is gradually worked into the centre with a spade or shovel, and incorporated with the lime by means of a *larry* [32], which resembles a large hoe with a long handle, and with a hole formed in the blade. With the larry the mortar is worked over till all the sand is incorporated and thoroughly mixed. Mortar so made is often kept for a day or two before use to ensure that the lime is thoroughly slaked, but this method only applies, as a rule, to pure and feebly hydraulic limes; the more eminently hydraulic limes and cements are usually ground.

Transporting Mortar. With ground limes and cements the proper proportions of aggregate and matrix are usually mixed dry, the necessary water added, and the whole intimately mixed, and conveyed as soon as possible to the scaffold for the bricklayers' use. This may be done in *hods* [29], which are made of such a size that they can also be used for carrying bricks, and are filled and carried by labourers to the point of use and tipped out on to *mortar boards*, boards about 30 in. square, from which the bricklayer picks the material up with his trowel [23], in building the wall on which he is working. In larger works it may be put into barrows or baskets or pails, and hoisted to the scaffold; in such cases the mortar is usually mixed as close as possible to the bottom of the hoist.

The Mortar Mill. Where a large and regular supply of mortar is required, a mortar mill is best employed; but this requires an engine or motor to drive it in most cases, though smaller mills worked by hand or by a horse have been used.

The mill itself [see **66**, page 645] consists of a circular iron pan from five to ten feet in diameter which revolves round a central pillar by means of machinery under two heavy rollers weighing together from one to three tons, and iron plates are used to direct the mortar, during mixing, under the rollers. Lime in lumps must be previously slaked. The ingredients are fed into the pan in their correct proportions, including a proper quantity of water, and are intimately mixed by the rollers. Where the aggregate requires to be crushed before use—as, for example, in the case of old brick, stone, pottery, etc.—the crushing should be performed by the rollers before the other ingredients are added.

Setting Gauged Work. Where rubbed and gauged work is employed it is not usual or possible to set it in ordinary mortar, which would be too coarse for the fine joints that are required in this class of work, but it is customary to set all such work that is completely finished before setting in pure lime putty. This is slaked and run into a bin, and kept moist till required for use, and is then worked up into a consistency resembling cream; the brick to be set has the surface dipped into the putty, and is then placed into position, and gently driven against the next brick. When this brick is set the putty should fill the joint and stand slightly in front of the general face like a small bead, which is afterwards cleaned off, and there should be no gaps, or cavities apparent on the face of the thin mortar-bed, which is usually not more than $\frac{1}{16}$ in. in thickness.

The joint being so fine, the use of lime without sand is permissible; but with thicker joints it would be undesirable, apart from the question of cost. Lime tends to contract somewhat during the process of setting, and it is partly on this ground that it is usual and desirable to add a fairly large proportion of sand or other incompressible aggregate in making lime mortar. Were this not done, in a lofty wall the loss of thickness in a great number of mortar joints would be very marked, and even with the usual proportion of sand there is a quite appreciable reduction in the height of brickwork laid in lime mortar during the process of setting.

Setting Gauged Work for Carving. A bed of lime putty never attains great hardness or strength, and is not suitable for use where the surface of the brick has afterwards to be cut away, as it must be when brickwork has to be carved. For such work it is usual to employ a mixture of white lead and shellac in forming the joints, and this, when set, allows the work to be treated by the carver as though it were a solid mass. Such carving should not be very deeply cut in—certainly not to such an extent as to penetrate the full depth of a brick below the original face, and where carving exceeding about 3 in. in projection is required it is desirable to construct the gauged work exclusively of headers.

It is not necessary to use this material in cases where the work is entirely finished before fixing, as is usually done with all moulded work round openings, and in the case of all plain walling or corbelling executed in gauged work and not intended for carving.

Continued

A SHORT DICTIONARY OF BRICKLAYING AND PAVING

See also SHORT DICTIONARIES OF BUILDING CONSTRUCTION (page 310) AND OF CIVIL ENGINEERING (page 1981)

AIR BRICK—A brick perforated to admit air into a building.

Air Flue—A conduit for the conveyance of air.

Annular Vault—A vault springing from two circular concentric walls.

Arch—An arrangement of blocks of material in the line of some curve supporting one another by mutual pressure, the outermost blocks resting on or against an abutment.

Architrave—The ornamental band of mouldings run round a door or window opening.

Archivolt—The ornamental band of mouldings worked on the voussoirs of an arch.

Arch Stone—See *voussoir*.

Archway—An arched opening in a building.

Axed Arch—A brick arch of which the bricks are roughly cut into the form of voussoirs.

BACK HEARTH—That part of a hearth within the recess for a fireplace.

Backing—The inner portion of a wall behind the facings.

Backs—Large shallow tanks into which malm earth is run to consolidate.

Bat—Either portion of a brick formed by dividing it across its length.

Batter—A term signifying that the face of a wall is not vertical, but is inclined backwards from its base.

Beam Filling—The filling in of walling between joists or rafters.

Bed—The upper and lower surfaces of a brick or similar block of material.

Bed Timber—The laying of timber plates on a mortar bed.

Bevel—The surface formed by cutting off an arris by a plane; *or*, a tool for setting out surfaces at various angles.

Bird's Mouth—A notch cut in the end of a brick used in bonding obtuse entering angles.

Blades—Loosely built walls of unburnt bricks formed in a kiln for burning.

Blue Brick—A strong, dense brick, dark blue in colour, largely made from Staffordshire clays.

Bolster—A tool used in cutting bricks.

Bond—The arrangement of bricks or stones throughout a wall so that successive courses interlock.

Bonding Iron—A small iron tie used to bind the two parts of a hollow wall.

Breaking Joint—The arrangement of materials so that cross joints in adjacent courses do not coincide.

Breeze—Fine ashes used in burning bricks.

Breeze Bricks—Blocks of breeze concrete the size of an ordinary brick.

Brick—A material produced by burning special forms of clay.

Brick nogging—Brickwork filled in between the timbers of a wood partition.

Brick on Edge—Bricks laid not flat but on edge.

Build-in—Fixing work into a wall as it proceeds.

Bullnose Brick—One having a quadrant curve at one corner.

Bull's Eye—A circular window or opening.

Burrs—Lumps of brick vitrified and run together in burning.

CASING—The covering of the outer face of a wall with another thin substance.

Cement Fillet—A band of cement, the upper surface sloped or weathered.

Chamfer—The surface formed by the cutting of an arris diagonally by a plane.

Chase—A shallow channel cut or formed on a wall face.

Chimney—A conduit for smoke or fumes.

Chimney Bar—An iron bar supporting the arch over a fireplace.

Chimney Bond—A special form of bonding used in chimneys.

Chimney Breast—The side of a chimney or group of chimneys next a room.

Chimney Piece—The fitting, usually ornamental, fixed in front of a fireplace.

Chimney Pot—A tube of terra-cotta or earthenware forming the finish to the top of a chimney.

Chimney Shaft—A large single chimney connected with a furnace or boiler.

Chimney Stack—A structure in which several chimneys are contained.

Chuffs—Bricks on which rain has fallen while burning—soft and useless.

Circular Work—A term applied to any work having a cylindrical face.

Clamp—A carefully-built stack of dried raw bricks for burning.

Closer—A brick cut in half lengthwise.

Coping—The course covering the top of a wall.

Copper—A receptacle for heating water by means of a furnace.

Corbel—A projection from the face of a wall to carry some superstructure.

Corbel Table—A continuous projection carried on corbels or projecting arches.

Core—The heart or centre of a wall; applied also to other objects.

Core and Parge—The operation of finishing the interior surface of a chimney flue.

Cornice—An ornamental course projecting from the face of a wall at or near the top.

Course—A layer of materials contained between two horizontal joints.

Creasing—Courses of tiles set in cement projecting beyond each face of a wall below a brick-on-edge coping.

Crown—The top of an arch or vault.

Cut and Pin-in—Cutting out a part of a wall to receive a step or other object and fixing same in securely.

Cutters—The best malm bricks used for gauged work.

Cylindrical Vault—One in the form of a segment of a cylinder.

DAMP COURSE—A layer of material impervious to moisture introduced into a wall.

Damper—A sliding diaphragm introduced into a flue to regulate the draught.

Dinas Firebrick—The most refractory firebrick made from Glamorganshire fireclay.

Discharging Arch—An arch built over a lintel to relieve it of the weight of the superstructure.

Dry Area—A space constructed outside a wall below the ground level to keep it dry.

Dwarf Wall—One that only rises a short distance from the ground.

EFFLORESCENCE—A floury substance, often occurring on new walls, due to crystallisation of salts in the materials used.

Elliptical Arch—One taking the form of an ellipse.

English Bond—The form in which headers and stretchers appear in alternate courses on the face.

Equilateral Arch—A pointed arch in which the chord subtending each curve equals the width at the springing.

Extrados—The upper surface of any arch.

FACINGS—Material of a selected quality for the face of a wall.

Faircutting—The careful preparation of bricks for special positions.

Fair Face—The face of a brick wall in which both headers and stretchers lie in a true plane.

Feeding Holes—Openings in a kiln to admit fuel.

Fender Wall—One built to carry the hearth of a fireplace.

Fillet—See *cement fillet*.

Firebrick—Bricks formed from refractory clays capable of withstanding high temperatures.

Fireclay—A refractory clay used in setting firebricks.

Fireplace—The place in a room provided for the fire.

Flat Arch—An arch formed with voussoir-shaped bricks, but having a flat soffit.

Flaunching—A weathered surface formed in mortar around a chimney pot.

Flemish Bond—The form in which headers and stretchers appear in the face alternately in every course.

Flue—A conduit for conveying air or smoke.

Flush—One surface is flush with another when they are in the same plane.

Flush-up—A term applied to filling up vertical joints with mortar.

Footings—Courses projecting on either side of the base of a wall to increase its bearing area and stability.

Frenchman—A tool used by a bricklayer in pointing.

Frog—A hollow formed in the face of some bricks.

GANISTER—An extremely refractory sandstone used in a powdered state for lining steel converters.

Gathering-over is causing successive courses of brickwork to overhang those below.

Gauged Brickwork—Work in which large bricks are rubbed down to exact dimensions.

Gault Bricks—Those manufactured from gault clay, usually hard and white.

Glazed Brick—One the face of which is covered with a transparent or opaque glaze.

Grizzles—Inferior soft bricks to which air has had access during burning.

Grout—Mortar or cement made liquid with water and poured into brick walls at intervals to fill up interstices.

HACKS—Long, low banks on which bricks are stacked to dry.

Haunch—The curved sides of an arch between the springing and crown.

Head—The horizontal member forming the top of an opening.

Header—A brick laid in a wall with its length perpendicular to the face.

Header Bond—A bond formed entirely of headers.

Hearth—A slab of incombustible material laid under and in front of a fireplace.

Hod—The receptacle in which a bricklayer's labourer carries mortar or bricks on his shoulder.

Hollow Wall—One in which a continuous cavity is provided between the inner and outer faces.

Honeycomb Wall—One built with intervals between the ends of the bricks.

Hood Mould—A moulding projecting beyond the wall above an opening.

Hoop-iron Bond—Strips of thin iron built into walls longitudinally.

Horseshoe Arch—One consisting of a part of a circle greater than a semicircle.

IMPOST—The top of a pier from which an arch springs.

Intrados—The under surface of any arch.

Inverted Arch—One of which the arch is formed below the level from which it springs.

JAMBS—The vertical sides of a door or window opening.

Jump—An abrupt change in the level of a horizontal course.

KERFS—Heaps of brick earth, dug and covered with fine ashes.

Kiln—A brick structure in which bricks are burnt.

King Closer—A brick cut to a bevel to show a face 2¼ in. wide.

LABOURS—A general term denoting work incidentally necessary, but not specifically described.

Lap—In brickwork, the horizontal distance between vertical joints in successive courses.

Larry—An instrument for mixing mortar.

Limewhite—A mixture of quicklime and water used as a wash.

MALM—A brick earth made in imitation of natural marl.

Marl—A brick earth containing much carbonate of lime.

Mat Sinking—A sunk space formed in the paving inside a door for a mat.

Mortar—The adhesive material formed of lime or cement and sand placed between adjacent bricks.

Mortar Board—A square board on which mortar is deposited on the scaffold.

Mortar Mill—A machine in which mortar is mixed.

Moulded Bricks—Those which have some special moulding on them.

Moulding—The process of forming clay into the form of a brick; also an ornamental contour applied to a surface to enrich it.

Mullion—A vertical pier sub-dividing an opening.

Mural—Appertaining to a wall.

NICHE—A recess formed in the thickness of a wall.

Nogging—See *brick-nogging.*

OBLIQUE ARCH—One in which the face is not perpendicular to the axis.

Offset—A ledge formed in a wall by reducing its thickness.

Oversailing Course—A course which overhangs the course below.

PANEL—A surface enclosed by moulding or other surfaces in different planes.

Parapet—A wall carried up above the level of the adjoining roof.

Parge—The process of rendering the inside of a flue.

Paviors—A hard quality of bricks used for paving.

Perpends—The perpendicular alignment of vertical joints.

Pier—A detached or projecting portion of brickwork or masonry carrying a concentrated load.

Pin-in—Fixing any work into a cavity prepared for it in a wall.

Pin-up—Finishing a new piece of wall tight up against superincumbent work.

Place Bricks—Soft under-burnt bricks, suited only for internal walls.

Plinth—A slight external projection at the base of a structure.

Plumb Rule—The tool with which a bricklayer ensures that walls are built truly vertical.

Pointing—The filling-in with mortar of joints in walling which have been previously raked out.

Pressed Brick—Bricks moulded by dry-clay machinery.

Pugging—A layer of material used to deaden sound.

Pug Mill—The receptacle in which brick earth is worked up before moulding.

Purpose-made Bricks—Those specially formed or moulded for a particular piece of work.

QUEEN CLOSER—A brick of the ordinary length and thickness, but only half the usual width.

Quoin—The external angles of a structure.

RACKING BACK—The end of a wall temporarily formed so that each course is set back by the extent of the lap.

Rake Out—The clearing out of mortar joints previous to pointing or rendering.

Ramp—A curved form connecting a higher and lower part of a wall.

Relieving Arch—See *discharging arch.*

Reveal—The vertical return on the outside of a door or window opening.

Rib—A projecting band, usually moulded, separating adjoining surfaces.

Rod—A standard measure of brickwork equivalent to 272¼ superficial feet of wall one and a half bricks thick.

Rough Arch—One formed with parallel sided bricks and irregular joints.

Rough Cutting—The cutting that may be done to brickwork on the scaffold or in position.

Rubbers—A special class of brick used for rubbed and gauged work.

Rubbing Stone—A gritty stone on which bricks are rubbed.

SAND MOULDING—Sprinkling the mould in brickmaking with sand, to prevent the clay adhering to it.

Scintling—Placing half-dried bricks diagonally at short spaces apart.

Scutch—A tool used for brick cutting.

Segmental Arch—An arch, the intrados of which forms less than a semicircle.

Set-off—A small ledge formed by reducing the thickness of a wall.

Shippers—Sound, hard bricks, not perfect in form, largely exported.

Sill—The horizontal member forming the bottom of an opening.

Skewback—The sloping abutment from which an arch springs.

Sleeper-wall—A low wall carrying the plate or sleeper for a floor.

Slop-moulding—When the mould in brickmaking is dipped in water to prevent the clay adhering to it.

Soil—Very fine ashes that are mixed with brick earth.

Splay Bricks—Those having one angle bevelled.

Splits—Bricks of usual length and breadth, but 1 in., 1½ in., or 2 in. thick.

Springer—The block of material from which an arch rises.

Springing—The horizontal line from which an arch rises.

Square—A tool used for setting out surfaces at right angles.

Squint—A brick used in bonding external obtuse angles.

Stilted Arch—One of which the springing is above the level of the impost.

Stock Board—The loose bottom of a brick mould.

Stocks—Hard, well-burnt bricks not perfect in form.

Stop—The term for the finish of a chamfer or moulding not run out.

Straight Arch—A gauged arch having a horizontal intrados.

Straight Joint—A vertical joint that extends through more than one course.

Stretcher—A brick laid in a wall, its length being parallel to the face of such wall.

Strike—A straight-edge used for removing surplus clay from a brick mould.

String Course—A small continuous horizontal projecting band or moulding.

Struck Joint—A joint with a weathered face, formed as the wall is built.

Surfacing Table—A table on which gauged work is set out.

TEMPERING—A process in preparing clay for brick-making.

Terra-cotta—A hard durable material composed of special clays and burnt in a kiln.

Tessellated Pavement—One composed of small cubes of suitable material.

Tessera—Small cubes of material used in forming mosaic work and tesselated pavements.

Tile Creasing—See *creasing.*

Tin Saw—A saw used for cutting lines into a brick.

Toothing—The end of a wall left with alternate courses projecting one quarter brick, with a view to continuous bonding when extended.

Trowel—The tool used for cutting and laying bricks.

Tuck Pointing—A narrow line of white lime putty worked on the face of ordinary pointing to imitate gauged work.

Tumbling—A method of finishing a sharply-inclined brick surface.

VERTICAL DAMP COURSE—One used in a vertical position in walls, the outer face of which is in contact with the soil.

Voussoir—Each of the wedge-shaped blocks of material of which an arch is formed.

WALL—A structure formed of small component substances used to separate adjoining areas or to enclose spaces.

Wall Tie—The ties of brick, terracotta, or metal used to construct the two parts of a hollow wall.

Washing—The process of mixing brick earth with mortar.

Weather Fillet—See *cement fillet.*

Weather Moulding—A moulding having its upper surface formed to throw off water.

White Bricks—Bricks of a whitish colour, largely made in Suffolk.

White Glazed Bricks—A brick with a fine white glazed surface.

Whitewash—A material made from whiting, often applied to brick interiors.

Whiting—A pure chalk ground in water and run through a fine sieve.

Wire-cut—A brick formed in a plastic clay machine.

With or Wythe—The partition separating the flues in a chimney stack.

Wood Brick—A block of wood the size of a brick built into a wall for fixing joinery.

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100 PHRASES FOR TRAVELLERS

A Concise Vocabulary for Tourists, with Phonetic Pronunciation, in Six Languages—English, French, German, Spanish, Italian, and Esperanto

	ENGLISH	FRENCH	GERMAN
		g indicates nasal sound. For explanation of mute e (ĕ) and other signs, see pages 123-4	″ — Strong stress. ′ — Medium stress
	Relating to Time		
1	What is the time ?	Quelle heure est-il ? Kell-ĕĕr-ey-teel ?	Wie viel Uhr ist es ? Vēē fēēl ōōhr eest ĕss ?
2	Call me at six o'clock	Eveillez-moi à six heures de matin Ev-ăye-ey-mwa-ah-seez-ĕĕr-dĕ-matan*g*	Wecken Sie mich um sechs Uhr morgen früh Vĕ″ckĕn zēē meech oom zĕks ōōhr mŏr″gĕn früh
3	To-day; to-night; this afternoon; this evening	Aujourd'hui; la nuit prochaine; cette après-midi; ce soir O-joor-dwee; la-nwēē-prosh-ane; set-aprey-meedee; sĕ-swahr	Heute; diese Nacht; diesen Nachmittag; diesen Abend Hoi″tĕ; dēēzĕ năcht; dēē″zĕn năch″-meettăch; dēē″zĕn ā″bĕnt
4	This morning; at noon; to-morrow	Ce matin; à midi; demain S'-matan*g*; ah-meedee; dĕ-man*g*′	Diesen Morgen; zu Mittag; Morgen Deezĕn mŏr″gĕn; tsōō mēēt″tăch; mor″-gĕn
5	The day after to-morrow	Après demain A′prey-dĕ-man*g*′	Übermorgen Ü″bĕrmŏr′gĕn
6	Next week	La semaine prochaine Lah-s'mane′-prosh-ane′	Die nächste Woche Dēē năich″stĕ wŏ″chĕ
7	As soon as possible	Au plus tôt Oh-ploo′-toh	So bald als möglich zoh bălt ălss mŏch″leech
8	Is it time to go ?	Est-il temps de partir ? Ey-teel-ton*g*-dĕ-parteer′?	Ist es Zeit abzureisen ? Eest ĕss tsīt ap″tsōōrīzĕn ?
9	When must I be ready ?	A quelle heure faut-il être prêt ? A kell-ĕĕr-foh-teel-eytrr-prey ?	Wann muss ich fertig sein ? Vănn mooss eech făyr″teech′ zīn ?
10	How long do you stay ?	Combien de temps arrêtez-vous ici ? Kon*g*-be-an*g*-dĕ-ton*g*-arreytey-vōō-zēēsee ?	Wie lang halten Sie hier ? Vee lăng hăl″tĕn zēē hēēr ?
11	How long will it take me to walk to the station ?	Combien de temps me faut-il pour aller à pied à la gare ? Kon*g*-be-an*g*-dĕ-ton*g*-mĕ-foh-teel-poor-alley-ah-pee-ey-ah-la-gahr ?	Wie viel Zeit brauche ich um zu Fuss den Bahnhof zu erreichen ? Vēē fēēl tsīt brow″chĕ ēēch oom tsōō fōōss dĕn băhn″hohf tsōō ĕrrī″chĕn ?
12	In how many days shall we do this journey ?	En combien de jours ferons-nous ce voyage ? On*g*-kon*g*-be-an*g*-dĕ-joor-ferron*g*-nōō-sĕ-voyah′j ?	In wie viel Tagen werden wir diese Reise machen ? Eĕn vēē fēēl tă″chĕn văyr″dĕn vēēr dēē rī″zĕ mă″chĕn ?
13	I am anxious to set out	Je voudrais sortir de suite Jĕ-vood-rey-sorteer′-dĕ-sweet′	Ich mochte gern gleich ausgehen Eech mŏch″tĕ găyrn glīch owss″gāy′hĕn
	On the Way		
14	Where shall we go ?	Où irons-nous ? Oo-eer′on*g*-nōō ?	Wohin sollen wir gehen ? Vohhĕēn″ zŏl″lĕn veēr gāy″hĕn ?
15	Is the road easy to find ?	Trouve-t-on facilement le chemin ? Troov′-ton*g*-fah-seel-mon*g*-lĕ-sh'man*g*	Ist der Weg leicht zu finden ? Eest dăyr văych līcht tsōō feen″dĕn ?
16	I did not understand	Je n'avais pas compris J' nah-vey-pah-kon*g*-pree	Ich verstand nicht Eech fĕrstănt″ neecht
17	What is the name of this village ?	Comment s'appelle ce village ? Kom-on*g*-sa-pell-sĕ-veelahj′?	Wie heisst dieses Dorf ? Vēē hīsst dēē″zĕs dŏrf ?
18	Are you coming with us ?	Venez-vous avec nous ? Veney-vōōz-ah-vek-nōō ?	Kommen Sie mit uns ? Kŏm″mĕn zēē meet oonss?
19	Shall we go with them ?	Irons-nous avec eux ? Eeron*g*-nōōz-ah-vek-ŭ ?	Sollen wir mit Ihnen gehen ? Zŏl″lĕn vēēr meet eeh″nĕn gāy″hĕn ?
20	When shall we set out ?	Quand partirons-nous ? Kon*g*-par-teeron*g*-nōō ?	Wann sollen wir abreisen ? Vănn zŏl″lĕn vēēr ăp″rī′zĕn ?

100 PHRASES FOR TRAVELLERS

A Concise Vocabulary for Tourists, with Phonetic Pronunciation, in Six Languages—English, French, German, Spanish, Italian, and Esperanto

Concluded from page 1812

SPANISH	ITALIAN	ESPERANTO	
Relating to Time			
¿ Que hora es ? Kay or′-ah es?	Che ora è ? Keh òrah èh ?	Kioma horo estas ? Kee-oh′-mah hoh′-roh ehs′-tahs?	1
Llámame á las seis Lyáh-mah-may ah lahs sáyis	Chiamatemi alle sei Keeahmàh-tehmee àhlleh sèhee	Veku min je la sesa Veh′-koo meen jeh lah seh′-sah	2
Hoy; esta noche; despues del mediodia; esta tarde Oy; és-tah nó-tchay; des-pooés del may-de-o-deé-ah; és-tah tár-day	Oggi; questa notte; questo dopo pranzo; questa sera Odgee; kooèh-stah nòtteh; kooèh-sto dòpo pràhn-dzo; kooèh-stah sèhrah	Hodiaŭ; hodiaŭ nokte; hodiaŭ posttagmeze; hodiaŭ vespere Hoh-dee′-ow; hoh-dee′-ow nohk′-teh hoh-dee′-ow pohst-tahg-meh′-zeh; hoh-dee′-ow vehs-peh′-reh	3
Esta mañana; al mediodia; mañana Es-tah man-yáh-nah; al may-de-o-dee′-ah; man-yáh-nah	Stamattina; a mezzo giorno; domani Stàh-mahtteè-nah; ah mèhdzo dgee-òrno; domàh-nee	Hodiaŭ matene; tagmeze; morgaŭ Hoh-dee′-ow mah-teh′-neh; tahg-meh′-zeh mohr′-gow	4
Pasado mañana Pas-sáh-doh man-yah-náh	Dopo domani Dòpo domàh-nee	La tagon post morgaŭ Lah tah′-gohn pohst mohr′-gow	5
La semana que viene Lah say-máh-nah kay ve-en′-eh	La settimana prossima Lah sehtteemàhnah pròsseemah	La semajnon sekvantan Lah seh-mahy′-nohn sehk-vahn′-tahn	6
Tan pronto como sea posible Tahn prón-toh có-mo sáy-ah pos-seé-blay	Al più presto possibile Ahl pee-oò prèhsto posseèbeeleh	Kiel eble plej baldaŭ Kee′-ehl eh′-bleh plehy bahl′-dow	7
¿ Es tiempo de marcharse ? Es te-em′-po day mar-tchar′-say?	È ora di partire ? Eh òrah dee pahr-teèreh ?	Ĉu estas forira tempo ? Choo ehs′-tahs foh-ree′-rah tehm′-poh?	8
¿ Cuando debo estar listo ? Cooan′-doh day′-bo es-tár lees′-toh?	A che ora devo esser pronto ? Ah keh òrah dèhvo èhssehr prònto ?	Kiam mi devos esti preta ? Kee′-ahm mee deh′-vahs ehs′-tee preh′-tah ?	9
¿ Cuanto tiempo se queda Vd. ? Cooan′-toh te-em′-po say kay′-dah oos-téd?	Quanto tempo vi fermate qui ? Kooàhn-to tèhm-po vee fehr-màhteh queè ?	Kiom da tempo vi intencas restadi ? Kee′ohm dah tehm′-poh vee een-tehn′-sahs rehs-tah′-dee ?	10
¿ Cuanto tiempo me tomará para andar hasta la estacion ? Cooan′-toh te-em′-po may toh-mar-áh páh-rah ahn-dár as′s-tah lah ess-tath-eon′ ?	Quanto tempo mi prenderà per andare a piedi alla stazione ? Kooàhn-to tèhmpo mee prehn-dehràh pehr ahndàhreh ah pee-èhdee ah′llah stah-tseeòneh ?	Kiom da tempo mi bezonas por piediri al la stacidomo ? Kee′-ohm dah tehm′-poh mee beh-zŏh′-nahs pohr pee-eh-dee′-ree ahl lah stah-tsee-doh′-moh?	11
¿ Cuantos dias nos tomará esta jornada ? Cooan′-toss deé-ahs noss toh-mar-áh és-tah hor-náh-dah?	In quanti giorni faremo questo viaggio ? Een kooàhn-tee dgee-òrnee fahrèhmo kooèh-sto veeàh-dgee-o?	Kiom da tagoj ni bezonas por fari tiun ĉi vojaĝon ? Kee′-ohm dah tah′-gohy nee beh-zoh′-nahs pohr fah′-ree tee′-oon chee voh-yah′-dgohn ?	12
Estoy ancioso de marchar Es-toy′ an-thee-ósso day mar-tchar′	Non vedo l'ora di partire Non vèhdo l'òrah dee pahr-teèreh	Mi deziras tuj forveturi Mee deh-zee′-rahs tooy fohr-veh-too′-ree	13
On the Way			
¿ Donde iremos ? Don′-day ee-ray′-moss?	Dove andremo ? Doveh ahndrèhmo?	Kien vi deziras, ke ni iru ? Kee′-ehn vee deh-zee′-rahs keh nee ee′-roo ?	14
¿ Es facil de encontrar el camino? Es fáth-il day en-con-trár el cah-meé-no?	È la via facile a trovarsi ? Eh lah veèah fàh-chee-leh ah trovàhrsee?	Ĉu la vojo estas facile trovebla ? Choo lah voh′-yoh ehs′-tahs fah-tsee′-leh troh-veh′-blah ?	15
No he comprendido No eh com-pren-deé-do	Non avevo capito Non ahvèhvo cahpeèto	Mi ne komprenis Mee neh kohm-preh′-nees	16
¿ Que nombre tiene esta aldea ? Kay nom′-bray te-en′-eh és-tah al-dáy-ah?	Come si chiama questo villaggio ? Còmeh see kee-àhmah koo-èhsto veellàh-dgeeo ?	Kiu estas la nomo de tiu ĉi vilaĝo ? Kee′-oo ehs′-tahs lah noh′-moh deh tee′-oo chee vee-lah′-dgoh ?	17
¿ Viene Vd. con nosotros ? Ve-en′-eh oos-téd con nos-só-tross	Venite con noi ? Vehneèteh con nòee?	Ĉu vi volas veni kun ni ? Choo vee voh′-lahs veh′nee koon nee ?	18
¿ Iremos con ellos ? Ee-ray′-moss con el-lyos?	Andremo con loro ? Ahndrèhmo con lòro?	Cu vi volas, ke ni akompanu ilin ? Choo vee voh′-lahs keh nee ah-kohm-pah′-noo ee′-leen ?	19
¿ Cuando nos marcharemos ? Cooan′-doh noss mar-tchar-éh-mos?	Quando partiremo ? Kooahn-do pahr-teerèhmo?	Kiam ni devos foriri ? Kee′-ahm nee deh′-vohs foh-ree′-ree?	20

	ENGLISH	FRENCH	GERMAN
	On the Way—continued		
21	Let us take a walk	Allons-nous promener Ahlong-nöö-prom′-enneh	Lassen Sie uns spazieren gehen Lăs″sĕn zēē oonss shpătsēē″rĕn gāy″hĕn
	On Arriving at a Place		
22	Have you got a letter for me ?	Est-ce que vous avez une lettre pour moi ? Eyss-kĕ- vöö - zahvey - zoon - lettr - poor-mwa ?	Haben Sie einen Brief für mich ? Hā″bĕn zēē īnĕn brēēf für meech ?
23	Are there any letters for me ?	Y a-t-il des lettres pour moi ? Ee-aht-eel-dey-lettr-poor-mwa ?	Sind Briefe für mich da ? Zēēnt brēē″fĕ für meech dā ?
24	When do the English letters arrive ?	A quelle heure arrivent les lettres d'Angleterre ? Ahk - ell - ěěr - arrēēv - ley - lettr-dang-lĕ-terr ?	Um welche Stunde kommen die Briefe aus England an ? Oom vĕl″chĕ stoon″dĕ kŏm″mĕn dēē brēē″fĕ owss ayng″lănt ăn ?
25	Where is the post-office ?	Pouvez-vous m'indiquer la poste ? Pöövey-vöö-mahng-dēē-keh-la-pohst ?	Welches ist der Weg zur Post ? V″el″chĕs eest dăyr vāych tsöör pōst ?
26	How much is the postage ?	Combien pour le port ? Kong-be-ang-poor-lĕ-pohr ?	Wie viel beträgt' das Porto ? Vēē fēēl băyträicht″ dăss pŏr″toh ?
27	Is there a concert this evening ?	Y a-t-il concert ce soir ? Ee-aht-eel-kong-sair-sĕ-swahr ?	Ist diesen Abend Conzert ? Eest dēē″zĕn ā″bĕnt cŏntsĕrt″ ?
28	Let us see the cathedral	Allons voir la cathédrale Ah-long-vwahr-la-ka-tehd-rahl′	Lassen Sie uns gehen die Domkirche zu sehen Lăssĕn zēē oonss gāy″hĕn dēē dohm″ keer′chĕ tsöō zāy″hĕn
	Train, Diligence, and Carriage		
29	When does the next train start ?	A quelle heure le prochain convoi part-il ? Ahk-ell - ěěr - lĕ - prosh - ang′ - kongvwa-pahr-teel ?	Wann fährt der nächste Zug ? Vănn fāīhrt dăyr nāich″stĕ tsooch ?
30	Is this the train to —— ?	Est-ce là le train pour —— ? Eyss-la-lĕ-trang-poor —— ?	Ist dies der Zug nach —— ? Eest dēēss dăyr tsooch năch —— ?
31	Please give me a first-class ticket to ——	Un billet de première classe s'il vous plait, pour —— Ung - bee - yeh - dĕ-prem-yair-klass, seel-vöö-pley-poor ——	Ich bitte um ein Billet erster Classe nach —— Eech beet″tĕ oom īn beelyĕt″ ayr″stĕ-clăs″sĕ năch ——
32	Porter, open the door of this carriage for me	Facteur, ouvrez-moi cette voiture Fahk-těěr-ööv′-rey-mwa-set-vwatt-ür	Kofferträger öffnen Sie mir diesen Wagen Kŏf″ĭĕr-trăī″gĕr ŏff″nĕn zēē mēēr dēē″ zĕn vā″gĕn
33	How far is it to —— ?	Combien y a-t-il d'ici à —— ? Kong-be-ang-ee-ah-teel-deesee-ah —— ?	Wie weit ist es von hier nach — ? Vēē vīt eest ĕss fŏn hēēr năch —— ?
34	How long does it take to reach —— ?	Combien de temps metterons-nous pour aller à —— ? Kong′-be-ang-dĕ - tong -mett - rong - nöö-poor-ahleh-ah —— ?	Wie lange fahren wir bis —— ? Vēē lăn″gĕ fāh″rĕn vēēr beess —— ?
35	Where is the luggage-office ?	Où est le bureau de bagage ? Oo-ey-lĕ-bü-roh-dĕ-bahg-gahj′ ?	Wo ist die Gepäckannahme ? Voh eest dēē gāypeck″ān′nāmĕ ?
36	Where is the telegraph-office ?	Pourriez-vous m'indiquer le bureau du telegraphe ? Poor - yey-vöö - mang - dee - keh - lĕ - bü - roh-dĕ-telegraff ?	Wo ist das Büreau des Telegraphen ? Voh eest dăss büroh″ dĕss tāylay′grā″ fĕn ?
37	Send for a cab	Faites chercher un fiacre Feyt-shersh-eh-ung-fee-ahkrr	Lassen Sie eine Droschke holen Lăs″sĕn zēē ī″nĕ drosh″kĕ hoh″lĕn
38	Drive me to the station	Conduisez-moi au chemin de fer Kong - dwēē′zey - mwa - oh - sh′mang-dĕ-ferr	Fahren Sie mich nach der Eisenbahn Fāh″rĕn zēē meech năch dăyr ī″zĕnbāhn
39	Can you drive us immediately to —— ?	Pouvez-vous nous conduire tout de suite à —— ? Pöövey-vöö-nöö kong-dweer-tood-sweet-ah —— ?	Können Sie uns sogleich nach —— fahren ? Kön″nĕn zēē oons zohglīch″ năch —— fāh″rĕn ?
40	What do you charge per hour ?	Combien demandez - vous par heure ? Kong - be-ang - deh -mong-dey-vöö-pahr-ěěr ?	Wie viel nehmen Sie für die Stunde ? Vēē fēēl nāy″mĕn zēē für dēē stoon″dĕ ?

SPANISH	ITALIAN	ESPERANTO	
On the Way—continued			
Vamos á dar un paseo Váh-moss ah dar oon pah'sáy-oh	Facciamo una passeggiata Fah-chee-àhmo oònah pahsseh-dgee-àhtah	Ni promenadu Nee proh-meh-nah'-doo	21
On Arriving at a Place			
¿ Tiene Vd. una carta para mí ? Te-en'-eh oos-ted' oon-ah car'-tah páh-rah mee ?	Avete lettere per me ? Ahvèhteh lèhttehreh pehr meh?	Ĉu vi havas leteron por mi ? Choo vee hah'-vahs leh-teh'-rohn pohr mee ?	22
¿ Hay cartas para mí ? Eye car'-tahs páh-rah mee ?	Ci sono lettere per me ? Chee sòno lèhttehreh pehr meh?	Ĉu alvenis leteroj por mi ? Choo ahl-veh'-nees leh-teh'-rohy pohr mee ?	23
¿ Cuando llegan las cartas Inglesas ? Cooan'-doh lyay'-gan lahs car'-tahs In-gles'-sahs ?	Quando arriva la posta d'Inghilterra ? Kooàhn-do ahrreè-vah lah po'stah deen-gheel-tèhrrah ?	Kiam alvenos leteroj el Anglujo ? Kee'-ahm ahl-veh'-nohs leh-teh'-rohy ehl ahn-gloo'-yoh ?	24
¿ Donde está la casa de correos ? Don'-day es-táh lah cás-ah day cor-ray'-ohs ?	Dov'è l'ufficio postale ? Dovèh looffeè-cheeo postàhleh ?	Kie estas la poŝtoficejo ? Kee'-eh ehs-tahs lah pohsh-toh-fee-tseh'-yoh ?	25
¿ Cuanto es el porte ? Cooan-toh es el por'-tay ?	Quant' è il porto ? Kooahntèh eel porto ?	Kiom estas la poŝtpago ? Kee'-ohm ehs'-tahs lah pohsht-pah'-goh ?	26
¿ Hay concierto esta noche ? Eye conth-e-air'-toh és-tah nó-tchay ?	C'è (nessun) concerto stasera ? Chèh (nehssoòn) conchèhr-to stahsèh-rah ?	Ĉu okazos koncerto hodiaŭ vespere ? Choo oh-kah'zohs kohn-tsehr'-toh hoh-dee'-ow vehs-peh'-reh ?	27
Vamos á ver la Catedral Vah-moss á vair lah cah-tay-drál	Andiamo a vedere il Duomo Ahndee-àhmo ah vehdèhreh eel Doo-òmo	Ni vizitu la katedralon Nee vee-zee'-too lah kah-teh-drah'-lohn	28
Train, Diligence and Carriage			
¿ Cuando sale el próximo tren ? Cooan'-doh sah-lay el proc'-se-mo tren ?	A che ora parte il prossimo treno ? Ah keh òrah pàhrteh eel pròsseemo trèhno ?	Kiam foriros la sekvonta vagonaro ? Kee'-ahm foh-ree'-rohs lah sehk-vohn'-tah vah-goh-nah'-roh ?	29
¿ Es este el tren para —— ? Es és-tay el tren páh-rah —— ?	È questo il treno per —— ? Eh kooèh-sto eel trèhno pehr —— ?	Ĉu tiu ĉi vagonaro iras al —— ? Choo tee'-oo chee vah-goh-nah'-ro ee'-rahs ahl —— ?	30
Déme Vd. un billete de primera clase para —— Day'-may oos-téd oon bil-lyeh'-tay day pree-mair-ah clas-say páh-rah ——	Mi dia un biglietto di prima classe per —— Mee deèah oon bee-'lee-èhtto dee preèmah clàh-sseh pehr ——	Bileton unuaklasan por ——, mi petas Bee-leh'-tohn oo-noo-ah-klah'-sahn pohr ——, mee peh'-tahs	31
Portero abra la puerta de este carruaje para mí Por-tair-o áh-brah lah pooer'-tah day és-tay car-roo-áh-hay páh-rah mee	Facchino, apritemi questa vettura Fahckeèno, ahpreètehmee kooèh-stah vehttoòrah	Portisto, malfermu la pordon de tiu ĉi fako Pohr-tees'-toh mahl-fehr'-moo lah pohr'-dohn deh tee'-oo chee fah'-koh	32
¿ Que distancia hay hasta —— ? Kay dis-tan'-theea eye ass-tah —— ?	Quanto è distante di qui —— ? Kooàhnto èh deestàhnteh dee queè —— ?	Kiel malproksime sidas —— ? Kee'-ehl mahl-prohk-see'-meh see'-dahs —— ?	33
¿ Cuanto tiempo hasta llegar á —— ? Cooan'-toh te-em'po ass-tah lyay'-gar ah —— ?	Quanto ci s'impiega per arrivare a —— ? Kooàhnto chee seempee-èhgah pehr ahrreevàh-reh ah —— ?	Post kiom da tempo oni atingos —— ? Pohst kee'-ohm dah tehm'-poh oh'-nee ah-teen'-gohs —— ?	34
¿ Donde está la oficina para el equipage ? Don'-day es-táh lah o-feeth-eé-nah páh-rah el eh-key-páh-hay ?	Dov'è l'ufficio bagagli ? Dovèh looffeè-cheeo bahgàh-'lee-ee ?	Kie estas la pakaĵejo ? Kee'-eh ehs'-tahs lah pah-kah-zheh'-yoh ?	35
¿ Donde está la oficina de telégrafos ? Don'-day es-táh lah o-feeth-eé-nah day tay-láy-grah-foes ?	Dov'è l'ufficio telegrafico ? Dovèh looffeè-cheeo tehlehgràhfeeco ?	Kie estas la telegrafejo ? Kee'-eh ehs-tahs lah teh-leh-grah-feh'-yoh ?	36
Mande por un coche Mahn-day por oon có-tchay	Cercate una carrozza Chehrcàhteh oònah cahrròtsah	Venigu fiakron Veh-nee'-goo fee-ah'-krohn	37
Lléveme á la estacion Lyáy-vay-may ah lah ess-tath-eon'	Alla stazione Ahllah stah-tseeòneh	Veturigu min al la stacidomo Veh-too-ree'-goo meen ahl la stah-tsee-doh'-moh	38
¿ Puede Vd. llevarnos imediatamente á —— ? Poeéd-eh oos-ted' lyay-var-noss ee-may'-dee-ah-tah-men-tay ah —— ?	Potete portarci subito a —— ? Potèhteh portàhr-chee soòbeeto ah —— ?	Ĉu vi povas tuj veturigi min al —— ? Choo vee poh'-vahs tooy veh-too-ree'-gee meen ahl —— ?	39
¿ Cuanto carga por hora ? Cooan'-toh car'-gah por ór-ah ?	Quanto fate pagare l'ora ? Kooàhnto fàhteh pahgàhreh lòrah ?	Kiom vi postulas laŭhore ? Kee'-ohm vee pohs-too'-lahs low-hoh'-reh ?	40

	ENGLISH	FRENCH	GERMAN
	Train, Diligence, and Carriage—continued		
41	What "tip" must I give the driver ?	Combien donne-t-on au cocher de pourboire ? Kong-be-ang-don-tong-oh-kosheh-dĕ-poor-bwahr ?	Wie viel Trinkgeld gibt man dem Kutscher ? Vēē fēēl treenk″gĕlt geebt măn dĕm koot″shĕr ?
42	Order the horses to be put to	Faites atteler Feyt-sahtell-eh	Lassen Sie anspannen Lăs″sĕn zēē ăn″spăn′nĕn
43	At what hour shall we arrive there ?	A quelle heure arriverons-nous à cet endroit ? Ah-kell-ĕĕr-ahree′v′rong-nōōz-asset-ong lrwah ?	Um wie viel Uhr werden wir an jenem Orte ankommen ? Oom vēē fēēl ōōhr văyr″dĕn vēēr ăn yăynĕm ŏr″tĕ ăn″kŏmmĕn ?
44	Can I hire a carriage to take me there ?	Pourrais-je louer une voiture pour m'y conduire ? Poor-eyj-lōō-eh-oon-vwat-ür-pōōr-me-kongdweer ?	Kann ich einen Wagen mietĕn, der mich dahin bringt ? Kănn eech ī″nĕn vă″gĕn mēē″tĕn, dayr meech dăheen″ breengt ?
45	Can we get a horse for the lady ?	Pourriez-vous me procurer un cheval pour madame ? Poor-yey-vōō-mĕ-prohk-üreh-ung-sh′vall′-poor-mah-dahm ?	Können wir ein Pferd für die Dame bekommen ? Kön′nĕn vēēr īn pfăyrt für dēē dă″mĕ băykŏm″mĕn ?
	At the Customs		
46	Where shall I find the customs ?	Où trouverai-je les douanes ? Oo-trōōvreyj-ley-dwahn ?	Wo ist der Zollamt ? Voh eest dăss tsŏll″ămt ?
47	I have nothing contraband	Je n'ai rien de contrabande Jĕ-ney-ree-ang-dĕ-kongtrah-bahngd	Ich habe gar keine Contrabande Eech hă″bĕ găr kī″nĕ cŏn″trăbăn″dĕ ?
48	How much have I to pay for this ?	Combien dois-je payer pour cela ? Kong-be-ang-dwahj-pey-yeh-poor-s'lah ?	Wie viel habe ich für dieses zu bezahlen ? Vēē fēēl hă″bĕ eech für dēē″zess tsōō băytsăh″lĕn ?
49	Here are the keys	Voici les clefs Vwahsee-ley-kley	Hier sind die Schlüssel Hēēr zeent dēē schlüs″sĕl
50	Have you finished ?	Avez-vous fini ? Avey-vōō-fēēnēē ?	Sind Sie fertig ? Zeent zēē făyr″teech ?
51	I thank you. Farewell	Je vous remercie. Adieu Jĕ-vōō-rĕmerrsee. Ah-dyĕ	Ich danke Ihnen. Adieu Eech dăn″kĕ ēēh″nĕn. Adēō″
	At an Inn		
52	Be so kind as to show me to my room	Voulez-vous bien me conduire à ma chambre ? Vooley-vōō-be-ang-mĕ-kongdwĕĕr-ah-ma-shawmbr ?	Wollen Sie mich zu mein Schlafzimmer führen ? Vŏl″lĕn zēē meech tsōō mīn schlăf″-tseem′mĕr füh″rĕn ?
53	On the first floor	Au premier étage Oh-prem-yeh-rehtahj	Im ersten Stocke Eem ăyr″stĕn stŏc″kĕ
54	On the ground floor	Au rez de chaussée Oh-reyd-shōhseh	Im Erdgeschosse Eem ăyrt″găyshŏs′sĕ
55	Where are our rooms ?	Où sont nos chambres ? Oō-song-noh-shawmbr ?	Wo sind unsere Zimmer ? Voh zeent oon″zăyrĕ tseem″mĕr ?
56	How much a day must I pay you ?	Combien faut-il vous payer par jour ? Kong be-ang-foht-eel-voo-pey-yeh-par-jōōr ?	Wie viel muss ich Ihnen für den Tag bezahlen ? Vēē fēēl moos eech ēēh″nĕn für dĕn tăch băy-tsăh″lĕn ?
57	Give me the key of my room	Donnez-moi le clef de ma chambre Dawney-mwa-lĕ-kleh-dĕ-ma-shawmbr	Gaben Sie mir den Schlüssel von meinem Zimmer ? Găy″bĕn zēē mēēr dĕn schlüs″sĕl fŏn mī″nĕn tseem″mĕr
58	Can I see the landlord of the hotel ?	Pourrais-je parler au maître de l'hôtel ? Pōōrrey-jĕ-parleh-oh-meytr-dĕ-lohtell′ ?	Ich wünsche den Herrn des Hauses zu sehen ? Eech vün″shĕ dĕn hăyrrn dĕss Low″zĕss tsōō zay″hĕn ?
59	Which is the best hotel ?	Quel est le meilleur hôtel ? Kell-ey-lĕ-măye-ĕĕr-ohtell′ ?	Welches ist der beste Gasthof ? Vĕl″chĕs eest dayr bĕs″tĕ găst″hohf ?
60	I want some writing-paper, and pen and ink	J'ai besoin de papier à lettres, avec de l'encre et des plumes Jey-bezwahng-dĕ-pahpye-rah-lettr-avek-dĕ-lohngkrr-eh-dey-plüm	Ich brauche etwas Briefpapier, mit Feder und Tinte Eech brow″chĕ ĕt″văss brēēf″păpēēr, meet făy″dĕr oont teen″tĕ
61	Open the door	Ouvrez la porte Oōvrey-la-port	Öffnen Sie die Thür Öff″nĕn zēē dēē tür
62	Bring my account	Apportez-moi la note Ahportey-mwa-la-nōht	Bringen Sie mir die Rechnung Breen″gĕn zēē mēēr dēē rĕch″noong
63	That is too much	C'est trop Sey-troh	Dass ist zu viel Dăss eest tsōō fēēl

Train, Diligence, and Carriage—continued

SPANISH	ITALIAN	ESPERANTO	
¿ Cuanto debo pagarle al cochero ? Cooan'-toh dáy'-bo pah-gár-lay al co-tchair'-o ?	Quanto devo dare al vetturino ? Kooàhnto dèhvo dàhreh ahl vehttoo-reèno ?	Kiom da trinkmono mi devas doni al la veturigisto ? Kee'-ohm dah treenk-moh'-noh mee deh'-vahs doh'-nee ahl lah veh-too-ree-gees'-toh ?	41
Dé la orden que se enganchen los caballos Day lah or'-den kay say en-gan'-tchen loss cah-bál-lyohs	Fate attaccare Fàhteh ahttahccàhreh	Ordonu, ke oni aljungu la ĉevalojn Ohr-doh'-noo keh oh'-nee ahl-yoon'-goo lah cheh-vah'-lohyn	42
¿ Á que hora llegaremos ? Ah kay or'-ah lyay-gar-éh-mos ?	A che ora arriveremo là ? Ah keh òrah ahrreevehrèhmo làh ?	Je kioma horo ni alvenos tie ? Yeh kee-oh'-mah hoh'-roh nee ahl-veh'-nohs tee'-eh ?	43
¿ Puedo alquilar un carruaje para llevarme alli ? Pooed-oh al-key-lar oon car-roo-áh-hay páh-rah lyay-vár-may al-lyeé ?	Posso prendere a nolo una carrozza per andarvi ? Pòsso prèhndehreh ah nòlo oo'nah cahrrò-tsah pehr ahndàhr-vee ?	Ĉu mi povas lui kaleŝon por porti min tien ? Choo mee poh'-vahs loo'-ee kah-leh-shohn pohr pohr'-tee meen tee'-ehn ?	44
¿ Podemos conseguir un caballo para la señora ? Po-dáy-moss con-say-geér oon cah-bal-lyo páh-rah lah sen-nyor'-ah ?	Si potrebbe avere un cavello per la signora ? See potrèhbbeh ahvèhreh oon cah-vàhllo pehr lah see-nee-òrah ?	Ĉu mi povas lui ĉevalon por la sinjorino ? Choo mee poh'-vahs loo'-ee cheh-vah'-lohn pohr lah seen-yoh-ree'-noh ?	45

At the Customs

SPANISH	ITALIAN	ESPERANTO	
¿ Donde encontraré la Aduana ? Don'-day en-con-trah-ráy lah ah-doo-áh-nah ?	Dov'è la dogana ? Dovèh lah dogàhnah ?	Kie estas la limdepagejo ? Kee'-eh ehs'-tahs lah leem-deh-pah-geh'-yoh ?	46
No tengo nada de contrabando No tain'-go náh-dah day con-trah-bahn'-doh	Non ho niente di contrabbando Non ò nee-èhnteh dee contrahbbàhndo	Mi havas nenion por konigi Mee hah'-vahs neh-nee'-ohn pohr koh-nee'-gee	47
¿ Cuanto tengo que pagar por esto ? Cooan'toh tain'-go kay pah-gár por ess'toh ?	Quanto devo pagare per questo ? Koo-àhnto dèhvo pahgàhreh pehr kooèhsto ?	Kiom mi devas pagi pro tiu ĉi ? Kee'-ohm mee deh'-vahs pah'-gee proh tee'-oo chee ?	48
Aqui estan las llaves Ah-kéy es-táhn lahs lyah-vays	Ecco le chiavi E'hcco leh kee-àhvee	'Jen la ŝlosiloj Yehn lah shloh-see'-lohy	49
¿ Ha acabado Vd. ? Ah ah-cáh-bah-doh oos-téd ?	Avete finito ? Ahvèhteh fee-neèto ?	Ĉu vi estas fininta ? Choo vee ehs'-tahs fee-neen'-tah ?	50
Gracias. Adios Gráh-theeas. Ah-deéos	Grazie. Addio Gràh-tsee-eh. Ahddeè-o	Mi dankas vin (or) Dankon. Adiaŭ Mee dahn'-kahs veen. Dahn'-kohn. Ah-dee'-ow	51

At an Inn

SPANISH	ITALIAN	ESPERANTO	
Tenga la bondad de conducirme á mi cuarto Tain'-gah lah bon-dád day con-doo-theer'-may ah mee coó-ar-toh	Abbia la gentilezza di mostrarmi la mia camera A'hbbeeah lah dgehn-teelèh-tsah dee mostràhrmee lah meèah càhmehrah	Bonvole konduku min al mia ĉambro Bohn-voh'-leh kohn-doo'-koo meen ahl mee'-ah chahm'-broh	52
En el primer piso En el pree-maír peé-so	Al primo piano Ahl preèmo pee-àhno	Sur la unua etaĝo Soor lah oo-noo'-ah eh-tah'-dgo	53
En el piso bajo En el peé-so báh-hoe	A pian terreno Ah pee-àhn tehrrèh-no	Sur la teretaĝo Soor lah teh-reh-tah'-dgo	54
¿ Donde estan nuestros cuartos ? Don'-day es-táhn noo'-és-troes coo-ár-toes ?	Dove sono le nostre camere ? Doveh sòno leh nòstreh càh-mehreh ?	Kie estas niaj ĉambroj ? Kee'-eh ehs'-tahs nee'ahy chahm'-brohy ?	55
¿ Cuanto tengo que pagarle al dia ? Coó-an-toh tain'-go kay pah-gar-lay al deé-ah ?	Quanto vi devo dare al giorno ? Kooàhn-to vee dèhvo dàhreh ahl dgee-òrno ?	Kiom por ĉiu tago mi devos pagi ? Kee'-ohm pohr chee'-oo tah'-go mee deh'-vohs pah-gee ?	56
Déme Vd las llaves de mi cuarto Dáy-may oos-téd lahs lyah-vays day mee coo-ar'-toe	Datemi la chiave della mia camera Dàhtehmee lah kee-àhveh dèhllah meè-ah càh mehrah	Donu al mi la ŝlosilon de mia ĉambro Doh'-noo ahl mee lah shloh-see'-lohn deh mee'-ah chahm'-broh	57
¿ Puede ver al patron ? Pooéd-eh vair al pah-trón ?	Vorrei parlare al proprietario dell' albergo ? Vorrèh-ee pahr-làhreh ahl propree-ehtàh-reeo dehllahl-bèhrgo ?	Mi volas paroli kun la hotel-mastro ? Mee voh'-lahs pah-roh'-lee koon lah hoh-tehl-mahs'-troh ?	58
¿ Cuál es el mejor hotel ? Coóal es el may-hór oh-tél ?	Qual'è il migliore albergo ? Kooahlèh eel mee-leeòreh ahl-bèhrgo ?	Kiu estas la plej bona hotelo ? Kee'-oo ehs'-tahs lah plehy boh'-nah hoh-teh'-loh ?	59
Necesito papel para escribir, pluma, y tinta Neth-es-seé-toe pah-pél páh-rah es-cree-beér, ploó-mah e tin'-tah	Ho bisogno di carta, penna e calamaio O' bee-sò-neeo dee càhrtah, pèhnna eh cahlah-màheeo	Mi deziras havi leterpaperon, plumon kaj inkon Mee deh-zee'-rahs hah'vee leh-tehr-pah-peh'-rohn ploo'-mohn kahy een'-kohn	60
Abre la puerta Ah-bray lah poo'-er'-tah	Aprite la porta Ahpreè-teh lah pòrtah	Malfermu la pordon Mahl-fehr-moo lah pohr-dohn	61
Traiga mi cuenta Try'-gah mee coo-en'-tah	Portatemi il conto Portàh-tehmee eel cònto	Alportu mian kalkulon Ahl-pohr'-too mee'-ahn kahl-koo'-lohn	62
Es demasiado Es day-mas-see-áh-doh	Questo è troppo Kooeh-stèh troppo	Tiu estas tro kara Tee'-oo ehs'-tahs troh kah'rah	63

	ENGLISH	FRENCH	GERMAN
	At an Inn—continued		
64	Are the sheets well aired?	**Est-ce que les draps de lit ont été bien aérés?** Eyss-kĕ-ley-drah-dĕ-lee-ton*g*-tehteh-be-an*g*-ah-eh-reh?	**Sind die Bett-tücher gut ausgelüftet?** Zeent dēē bĕt″tüchĕr gōōt owss″gāy lüf′tĕt?
	At Meals		
65	Keep me a place at the table d'hôte	**Reservez-moi une place à la table d'hôte** Reh-zervey-mwa-oon-plahss-ah-lah-tahbl-dōht	**Belegen Sie ein Platz an der table d'hôte für mich** Băylāy″gĕn zēē īn plāts ăn dāyr tābl d'hoht für meeeh
66	Give me a glass of water	**Donnez-moi un verre d'eau** Dawney-mwa-un*g*-veyr-dŏh	**Geben Sie mir ein Glas Wasser** Gāy″bĕn zēē mēēr īn glāss văs″sĕr
67	Waiter, I wish to breakfast	**Garçon, je voudrais déjeûner** Gahr-zon*g*-jĕ-vōōd′rey deh′jüneh	**Kellner, ich mochte frühstucken** Kĕll″nĕr, eēch mŏch″tĕ früh″stüc′kĕn
68	Give me: tea, chocolate, coffee, fresh butter, white bread, white rolls, brown bread, new-laid eggs in the shell	**Donnez-moi du thé, du chocolat, du café, du beurre frais, du pain de froment, des petits pains au lait, du pain bis, des œufs frais à la coque** Dawney-mwa-dü-teh, dü-shŏkolah′, dü kahfeh, dü-bēērr-frey, dü-pan*g*-dĕ fromon*g*, dey-p′tee-pan*g*-zoh-ley, dü-pan*g*-beece, dey-zü-frey-ah-la-kok	**Geben Sie mir Thee, Chokolade, Kaffee, frische Butter, Weizenbrod, kleine Meelch′bröte, schwarzes Brod, frische Eier in der Schale gesotten** Gāy″bĕn zēē mēēr tāy, schŏkōlā″dĕ, kăf″fāy, frees″shĕ boot″tĕr, vīt″sĕn-broht, klī″nĕ meelch″brötĕ, schwăr″tsĕss broht, frees″shĕ ī″ĕr een dayr schālĕ, gāyzŏt″tĕn
69	Have you any fruit? What kind of fruit have you?	**Avez-vous du fruit? Quelle espèce de fruit avez-vous?** Avey-vōō-dü-frwee? Kell-espeyss′-dĕ-frwee-tahvey vōō?	**Haben Sie Obst? Was für Obst haben Sie?** Hā″bĕn zēē ohbst? Văss für ohbst hā″bĕn zēē?
70	Is your fruit ripe?	**Vos fruits sont-ils bien mûrs?** Voh-frwee-son*g*-teel-be-an*g*-mür?	**Sind Ihre Früchte auch reif?** Zeent ēēh″rĕ früch″tĕ owch rīf?
71	This fruit is not ripe enough	**Ce fruit n'est pas assez mûr** Sĕ-frwee-ney-pah-zassey-mür?	**Dieses Obst ist nicht reif genug?** Dēēz″ĕs ohbst eest neecht rīf gāynooch″
72	This meat is so tough that I cannot eat it	**Cette viande est si dure qu'il est impossible de la manger** Set-vee-āhn*g*d-ey-see-dür-keel-eyt-an*g*posseebl-dĕ-lāh-mon*g*jeh	**Dieses Fleisch ist so hart, dass es mir unmöglich ist, es zu essen** Dēēzĕs flīsh eest tsōō hart, dass ĕss mēēr oonmöch″leech eest ĕss tsōō ĕs″sĕn
73	Give me something else	**Donnez-moi autre chose** Dawney-mwa-ōhtr-shōhz	**Geben Sie mir etwas anderes** Gāy″bĕn zēē mēēr ĕtvăss ăn″dāyrĕss
74	What wines have you?	**Quels vins avez-vous?** Kell-van*g*-zahvey-vōō?	**Was für Weine haben Sie?** Văss für vīnĕ hā″bĕn zēē?
75	What is the price of this wine?	**Quel est le prix de ce vin?** Kell-ey-lĕ-pree-dĕ sĕ-van*g*?	**Was ist der Preis dieses Weins?** Văss eest dāyr prīss dēē″zĕs vīnss?
76	Show me the wine list	**Montrez-moi la carte des vins** Mon*g*trey-mwa-la-kahrt-dey-van*g*?	**Zeigen Sie mir Ihr Weinkarte** Tsī″chĕn zēē mēēr ēēh″rĕ vīn″kăr′tĕ
77	Show me the bill of fare	**Montrez-moi la carte** Mon*g*trey-mwa-la kahrt	**Zeigen Sie mir den Speisezettel** Tsī″chĕn zēē mēēr dĕn spī″zĕ-tsĕt″tĕl
78	What do you call that dish?	**Quelle nom donnez-vous à ce plat?** Kell-non*g*-dawney-vōō-ass-plah?	**Welchen Namen geben Sie diesem Gerichte?** Vĕl″chĕn năm″en gāy″bĕn zēē dēē″zĕm gāyreech″tĕ?
79	How much do you charge for dinner?	**Combien faites-vous payer pour le dîner?** Kon*g*be-an*g*-feyt-vōō-pey-yeh-poor-lĕ-deeneh?	**Wie viel berechnen Sie für das Mittagsessen?** Vēē fēēl băyrĕch″nĕn zēē für dăss meet″tăchĕssĕn?
80	At what time is your table d'hôte?	**A quelle heure dîne-t-on à la table d'hôte?** Ahk-ell-ēēr-deen-ton*g*-ah-lah-tahbl-dōht?	**Um wie viel Uhr ist die table d'hôte?** Oom vēē fēēl ōōhr eest dēē tābl d'hoht″?
	Asking Directions		
81	Will you be so good as to tell me the way to —— street?	**Voulez-vous avoir la bonté de me dire quel est le chemin pour aller à la rue ——?** Vooley-vōō-zavwahr-la-bon*g*teh-dĕ-mĕ-deer-kell-ey-lĕ-sh′man*g*-poor-ahleh-ah-la-rü ——?	**Wollen Sie wohl die Güte haben und mir den Weg nach —— Strasse zeigen?** Vŏllĕn zēē vohl dēē gü″tĕ hā″bĕn oont mēēr dĕn vāych năch —— strās″sĕ tsī″chĕn?

At an Inn—continued

SPANISH	ITALIAN	ESPERANTO	
¿ Estan las sábanas bien secas ? Es-tahn lahs sáh-bah-nahs bé-en' say'-cahs ?	Le lenzuola sono ben asciutte ? Leh lehn-dzoo-òlah sono behn ahshoòtteh ?	Ĉu la littukoj estas tute sekaj ? Choo lah leet-too'-kohy ehs'-tahs too'-teh seh'-kahy ?	64

At Meals

SPANISH	ITALIAN	ESPERANTO	
Guárdame un sitio á la mesa de huéspuedes (or table d'hote) Goó-ar-dah-may oon seé-teo ah lah més-sah day oo-es'-ped-ehs	Tenetemi un posto alla "table d'hôte" Tehnèhteh-mee oon pòsto àhllah, etc.	Rezervu lokon por mi ĉe la komuna tablo Reh-zehr'-voo loh'-kohn pohr mee cheh lah koh-moo'-nah tah'-bloh	65
Déme Vd. un vaso de agua Dáy-may oos-téd oon vas-so day áh-goo-ah	Datemi un bicchier d'acqua Dàhtehmee oon bee-kee-èhr dàhqquah	Donu al mi glason da akvo Doh'-noo ahl mee glah'-sohn dah ahk'-voh	66
Mozo deseo almorzar Móth-o des-say'-o al-mor-thár	Cameriere, voglio far colazione Cahmeh-ree-èhreh, vò-'leeo fahr colah-tseeòneh	Kelnero, mi deziras matenmanĝi Kehl-neh'-roh, mee deh-zee'-rahs mah-tehn-mahn'-dgee	67
Déme Vd. té; café; chocolate; manteca fresca; pan blanco; panecillos; pan cacero; huevos frescos pasados por agua Day-may oos-téd tay; cah-fáy; tcho-co-láh-tay; man-táy'-cah fres-cah; pahn blah'n-co, pahn-eth-eel"-lyoes; pahn cath-air'-o, oo-ay'-voes frés-coes pas-sáh-dohs por áh-goo-ah	Datemi del tè; del caffè; della cioccolata; del burro fresco; del pane bianco; dei panini; del pan nero; delle uova fresche al guscio Dàteh-mee dehl tèh; dehl cahffèh; dèh-llah chockolàhtah; dehl boòrro frèh-sko; dehl pàhneh bee-àhnco; dèhee pahneènee; dehl pahn nèhro; dèhlleh oo-òvah frèhskeh ahl goò-sho	Donu al mi teon, kafon, ĉokoladon, sensalan buteron, blankan panon, blankajn panbulkojn, brunan panon, ovojn freŝajn en ŝeloj Doh'-noo ahl mee teh'-ohn, kah'-fohn, choh-koh-lah'-dohn, sehn-sah'-lahn boo-teh'-rohn, blahn'-kahn pah'-nohn blahn'-kahyn pahn-bool'-kohyn, broo'-nahn pah'-nohn, oh'-vohyn freh'-shahyn ehn sheh'-lohy	68
¿ Tiene Vd. fruta ? Que especie de fruta tiene Vd. ? Te-en'-eh oos-téd froó-tah? Kay es-péth-e-eh day froó-tah té-eny oos-téd ?	Avete della frutta ? Che frutta avete ? Ahvèhteh dèhllah froòttah? Keh froòttah ahvèhteh ?	Ĉu vi havas fruktojn ? Kiajn fruktojn vi havas ? Choo vee hah'-vahs frook'-tohyn? Kee'-ahyn frook'-tohyn vee hah'-vahs ?	69
¿ Es su fruta madura ? Es soo froó-tah mah-doó-rah ?	Sono mature le frutta ? Sòno mahtoòreh leh froòttah ?	Ĉu viaj fruktoj estas maturaj ? Choo vee'-ahy frook'-tohy ehs'-tahs mah-too'-rahy ?	70
Esta fruta no es bastante madura Es'-tah froó-tah no es bas-tahn'-tay mah-doó-rah	Queste frutta non sono abbastanza mature Koo-èhsteh froòttah non sòno ahbbah-stàhndza mahtoòreh	Tiu ĉi frukto ne estas sufiĉe matura Tee'-oo chee frook'-toh neh ehs'-tahs soo-fee'-cheh mah-too'-rah	71
Esta carne es tan dura que no la puedo comer Es'-tah car'-nay es tahn doó-rah kay no la poo-éd-oh co-mair	Questa carne è cosi dura che non posso mangiarla Koo-èhstah càhrneh èh coseè doòrah keh non pòsso mahn-dgee-àhrlah	Tiu ĉi viando estas tiel malmola, ke mi ne povas ĝin manĝi. Tee'-oo chee vee-ahn'-doh ehs'-tahs tee'-ehl mahl-moh'-lah keh mee neh poh'-vahs dgeen mahn'-dgee.	72
Déme Vd. otra cosa Day'-may oos-téd ó-trah cos'-sah	Datemi qualche altra cosa Dàhtehmee koo-àhl-keh àhltrah co'sah	Alportu ion alian Ahl-pohr'-too ee'-ohn ah-lee'ahn	73
¿ Que vino tiene Vd. ? Kay veé-no te-en'-eh oos-téd ?	Che vini avete ? Keh veènee ahvèhteh ?	Kiajn vinojn vi havas ? Kee-ahyn vee-nohyn vee hah-vahs?	74
¿ Cual es el precio de este vino ? Coo-ál es el pray'-theeo day és-tay veé-no ?	Qual'è il prezzo di questo vino ? Koo-ahlèh eel prèh-tso dee koo-èhsto veèno ?	Kiom kostas tiu ĉi vino ? Kee'-ohm kohs'-tahs tee'-oo chee vee'-noh ?	75
Enséñeme Vd. la lista de los vinos En-sáy-nyeh-may oos-téd lah lees'-tah day los veé-nohs	Mostratemi la lista dei vini Mostràhteh-mee lah leèstah dèh-ee veènee	Donu al mi la vinkarton ? Doh'-noo ahl mee lah veen-kahr'-tohn	76
Enseñeme Vd. la lista de la comida En-sáy-nyeh-may oos-téd lah lees'-tah day lah co-meé-dah	Mostratemi la carta Mostràhteh-mee lah càhrtah	Donu al mi la manĝokarton Doh'-noo ahl mee lah mahn-dgoh-kahr'-tohn	77
¿ Como llama Vd. este plato ? Có-mo lyáh-mah oos-téd es'-tay pláh-toe ?	Come chiamate questo piatto ? Comeh kee-ahmàhteh koo-èhsto peeàhtto ?	Kiel vi nomas tiun ĉi manĝaĵon ? Kee'-ehl vee noh'-mahs tee'-oon' chee mahn-dgah'-zhohn ?	78
¿ Cuanto carga Vd. por la comida ? Coo-an'-toh car'-gah oos-téd por la co-meé-dah ?	Quanto fate pagare per il pranzo ? Koo-àhnto fàhteh pahgàh-reh pehr eel pràhn-dzo ?	Kia prezo estas la vespermanĝo ? Kee'-ah preh'-zoh ehs'-tahs lah vehs-pehr-mahn'-dgoh ?	79
¿ A que hora es su mesa de huespedes ? Ah kay ór'-ah es soo més-sah day o-es'-ped-ehs ?	A che ora è la table d'hôte ? Ah keh òrah eh lah, etc.	Je kioma horo okazas la komuntabla manĝado ? Yeh kee-oh'-mah hoh'roh oh-kah'-zahs lah koh-moon-tah'-blah mahn-dgah-doh ?	80

Asking Directions

SPANISH	ITALIAN	ESPERANTO	
¿ Quiere Vd. tener la bondad de darme la direccion; de la calle de —— ? Key-air'-eh oos-téd tain-aír lah bon-bád day dár-may lah dee-rec-theón day lah cal'-lyay day —— ?	Abbia la gentilezza d' indicarmi la strada per andare in via —— ? A'hbbee-ah lah dgehntee-lèhtsah deendee-càrmee lah stràhdah pehr ahndàh-reh een veè-ah —— ?	Bonvole montru al mi la vojon al —— strato ? Bohn-voh'-leh mohn'-troo ahl mee lah voh'-yohn al —— strah'-toh ?	81

	ENGLISH	FRENCH	GERMAN
	Asking Directions—continued		
82	I wish to go to Mr. N's; is it far from here?	Je cherche la maison de Mons. N.; est-ce qu'elle est loin d'ici? Jĕ-shersh - la - meyzong - dĕ - M'ssyü N.; eyss-kell-ey-lwang-deesee?	Ich suche das Haus des Herrn N.; ist es weit von hier? Eech zōō″chĕ dăss howss dĕss hăyrn N.; eest ĕss vīt fŏn hēēr?
83	Which is the way to it?	De quel côté dois-je aller? De-kell-kohteh-dwăhj-ahleh?	Nach welcher Seite muss ich gehen? Nach vĕl″chĕr zī″tĕ mooss eech găy″hĕn?
84	Does Mr. N. live here?	Est-ce que Mons. N. demeure ici? Eyss-kĕ-M'ssyü N. dehmür-eesee?	Wohnt Herr N. hier? Vohnt hăyr N. hēēr?
85	Coachman, drive me to —— street	Cocher, conduisez-moi à la rue —— Kosheh, kongdweezey - mwa-ah - la - rü ——	Kutscher, wollen Sie mich zur —— Strasse fahren Koot″shĕr, vŏllĕn zee meech tsōōr —— străs″sĕ fāh″rĕn
	In the Bedroom		
86	Will you give me a box of matches?	Voulez-vous m'apporter les allumettes? Vooley-vōō-maporteh-ley-zahlümett?	Wollen Sie mir die Schachtel Zündhölzchen bringen? Vŏl″lĕn zēē mēēr dēē schach″tĕl tsünt″-hölts′-chĕn breen″gĕn?
87	Will you send up the chamber-maid?	Voulez-vous nous envoyer la femme de chambre? Vooley-vōō-nōōz-ongvwa-yeh-la-fam-dĕ-shawmbr?	Wollen Sie das Zimmermädchen schicken? Vŏl″len zēē dăss tseem″mĕr-māīt′chĕn scheec″kĕn?
88	I want my linen washed	Il faut que je fasse blanchir Eel-foh-kĕ-jĕ-fahss-blongsheer	Ich muss meine Wäsche waschen lassen Eech mooss mīnĕ vĕ″shĕ văs″shĕn lăs″sĕn
89	Bring me a towel	Apportez-moi un essuie-main Ahportey-mwa-unesswee-mang	Bringen Sie mir ein Hand′tuch Breen″gĕn zēē mēēr īn hănt″tōōch
90	I want my coat brushed	Voulez-vous faire brosser ma redingote Vooley - vōō - feyr - brosseh - ma-redeng-goht	Ich wünsche meinen Rock ausgebürstet zu haben Eech vün″shĕ mī″nĕn rŏck owss″găy-bürsh′tĕt tsōō hā″bĕn
91	Can I have a warm bath?	Puis-je avoir un bain chaud? Pweej-ahvwahr-ung-bang-shoh?	Kann ich ein warmes Bad bekommen? Kănn eech īn văr″mĕs băt băykŏm″mĕn?
92	I should like warm water for washing	Je desire de l'eau chaude pour me laver Jĕ-d'zeer-dĕ-loh-shohd-poor-mĕ-lahveh	Ich wünsche warmes Wasser zum Waschen Eech vün″shĕ văr″mĕs văs″sĕr tsōōm văs″shĕn
	At the Shops		
93	What is the price of this article?	Quel est le prix de cet objet? (or) Que coûte cet objet? Kell-ey-lĕ-pree-dĕ-set-ohbjey? (or) Kell-koot-set-ohbjey?	Was ist der Preis dieses Artikels? Văss eest dăyr priss dēē″zĕs ăr″teekĕlss?
94	What is the name of that?	Comment s'appelle cela? Komong-sahpell-s'lah?	Wie heisst das? Vēē hīsst dăss?
95	That is rather dear	C'est un peu cher Set-ung-pĕ-sheyr	Das ist etwas teuer Dăss eest ĕt″văss toi″ĕr
96	Where is a chemist's?	Pouvez-vous m'indiquer une pharmacie? Poovey-vōō - mangdeekeh-oon-fahrmah-see?	Wo ist ein Apotheke? Voh ēēst i″nĕ ăpohtăy″kĕ?
97	Where can I get my money changed?	Où pourrai-je changer de l'argent? Oo-poorey-jĕ-shawng-jeh-dlahrjong?	Wo kann ich Geld wechseln lassen? Voh kănn eech gĕlt vĕch′sĕln lăs″sĕn?
98	Be so kind as to show me that	Ayez la bonté de me montrer cela Ey-yey-la - bongteh - dĕ - mĕ - mongtreh-s'lah	Seien Sie so gut mir das zu zeigen Zī″hĕn zēē zoh gōōt mēēr dăss tsōō tsī″chĕn
99	I wish to buy that	Je voudrais acheter cela Jĕ-vōōdrey-ashteh-s'lah	Ich wollte gern dies kaufen Eech vŏll″tĕ găyrn dēēss kow″fĕn
100	Is there a book here containing the curiosities of the town?	Y a-t-il ici un livre des curiosités de cette ville? Ee-aht-eel-eesee -ung - leevr - dey-küree-ohseeteh-dĕ-set-veel?	Gibt es hier ein Buch, welches von den Merkwürdigkeiten dieser Stadt handelt? Geebt ĕss hēēr īn bōōch, vĕl″chĕs fŏn dĕn măyrwür″dĕech-kī′tĕn dēēzĕr stăt hăn′dĕlt?

Travel concluded

SPANISH	ITALIAN	ESPERANTO	
Asking Directions—continued			
Deseo ir á casa del señor N.; esta lejos de aqui? Des-sáy-o eer ah cas-sah del sen-nyor' N., es-táh lay'-hos day ah-kéy?	Desidero andare dal signor N.; abita lontano di qui? Dehseè-dehro ahndàh-reh dahl seenee-òr N.; àhbeetah lontàhno dee qu-eè?	Mi deziras iri ĉe Sinjoron N. Ĉu ĝi estas malproksime de tie ĉi? Mee deh-zee'-rahs ee'-ree cheh Seen-yoh'-rohn N. Choo dgee ehs'-tahs mahl-prohk-see'-meh deh tee'-eh chee?	82
¿Cual es el camino para ir alli? Coo-ál es el cah-meé-no páh-rah eer al-lyeé?	Quale strada devo seguire per andarvi? Koo-àhleh stràh-dah dèhvo sehgu-eèreh pehr ahndàhrvee?	Kiu estas la vojo tien? Kee-oo ehs-tahs lah voh'-yoh tee'-ehn?	83
¿Vive aqui el señor N.? Veé-vay ah-kéy-el sen-nyor' N.?	Abita qui il signor N.? A'hbeetah queè eel see-neèor N.?	Ĉu Sinjoro N. loĝas tie ĉi? Choo Seen-yoh'-roh N. loh'-dgahs tee'-eh chee?	84
Cochero, lléveme á la calle de —— Co-tchair-o lyáy-vay-may ah lah cál lyay day ——	Cocchiere, conducetemi in via —— Co-ckee-èhreh condoo-chètehmee een veèah ——	Veturilisto. Veturigu min al —— strato Veh-too-ree-lees-toh. Veh-too-ree-goo meen ahl —— strah-toh	85
In the Bedroom			
¿Quiere Vd. darme una caja de cerillos? Key-air'-eh oos-téd dár-may oon'-ah cáh-ha day thair-reél-lyoes?	Mi vuol favorire una scatola di fiammiferi? Mee voo-òl fahvoreèreh oònah scàh-tolah dee fee-ahmmeè-fehree?	Bonvole alportu alumetojn? Bohn-voh'-leh ahl-pohr'-too ah-loo-meh'-lohyn?	86
¿Quiere Vd. mandarme la doncella? Key-air'-eh oos-téd man-dăr-may lah don-thay'l-lyah?	Faccia il favore di mandar su la cameriera? Fàh-chee-ah eel fah-vòreh dee mahn-dàhr soò lah cahmehree-èhrah?	Bonvole alsendu la ĉambristinon? Bohn-voh'-leh ahl-sehn'-doo lah chahm-brees-tee'-nohn?	87
Necesito que laven mi ropa Neth-es-seé-toe kay láh-ven mee roé-pah	Fatemi lavare la biancheria Fàhteh-mee lahvàhreh lah bee-ahn-keh-reèah	Mi deziras, ke oni lavu mian tolaĵon Mee deh-zee'-rahs kee oh'-nee lah'-voo mee'-ahn toh-lah'-zhohn	88
Traígame una toalla Try'-gah-may oon'-ah toe-al'-lyah	Portatemi un asciugamani Portàhteh-mee oon ahshoògah-màhnee	Aportu viŝilon Ahl-pohr'-too vee-shee'-lohn	89
Necesito que se cepille mi chaqueta Neth-es-seé-toe kay say thay-píl-lyay mee tchah-két-ah	Fatemi spazzolare l' abito Fàhteh-mee spah-tsolàhreh làhbeeto	Mi deziras, ke oni brosu mian veston Mee deh-zee'-rahs keh oh'-nee broh'-soo mee'ahn vehs'tohn	90
¿Puedo tomar un baño caliente? Poo-éd-oh toe-már oon bahn'-nyo cah-le-en'-tay?	Si può fare un bagno caldo? See poo-ò fàhreh oon bàh-nee-o càhldo?	Ĉu mi povas havi varman banon? Choo mee poh'-vahs hah'-vee vahr'-mahn bah'-nohn?	91
Me gustaría tener agua caliente para lavarme May goos-tah-reé-ah tain-air' áh-goo-ah cal-e-en'tay páh-rah lah-vár-may	Vorrei dell' acqua calda per lavarmi Vorrèh-ee dehllàhckoo-ah càhldah pehr lahvàhr-mee	Mi deziras havi varman akvon por min lavi Mee deh-zee'-rahs hah'-vee vahr'-mahn ahk'-vohn pohr meen lah'-vee	92
At the Shops			
¿Cual es el precio de este articulo? Coo-ál es el pray'-theeo day és-tay ar-teé-coo-lo?	Qual'è il prezzo di questo articolo? Koo-ahlèh eel prèhtso dee koo-èhsto ahr-teècolo?	Kiom kostas tiu ĉi objekto? Kee'-ohm kohs'-tahs tee'-oo chee ohb-yehk'-toh?	93
¿Que nombre tiene esto? Key nom'-bray te-en'-eh és-toh?	Come si chiama questo? Còmeh see kee-àhmah koo-èhsto?	Kiel oni nomas tion? Kee'-ehl oh'nee noh'mahs tee'ohn?	94
Esto es un poco caro Es'-toh es oon pó-co cáh-roh	E' piuttosto caro E'h pee-oottòsto càhro	Tio estas iom kara Tee'-oh ehs'-tahs ee'-ohm kah'rah	95
¿Donde hay un farmacéutico? Don'-day eye oon far-math-éh-oo-tee-co?	Può in icarmi una farmacia? Poo-ò eendeecàhr-mee oònah fahr-mah-cheè-ah?	Kie loĝas apotekisto? Kee'-eh loh'-dgahs ah-poh-teh-kees'-toh?	96
Donde puedo cambiar mi dinero? Don'day poo-ed-oh cam-bee-ár mee dee-naír-o?	Dove posso cambiare del danaro? Dòveh pòsso cahmbee-àhreh dehl dahnàhro?	Kie mi povas ŝanĝigi mian monon? Kee'-eh mee poh'-vahs shahn-dgee'-gee mee'-ahn moh'-nohn?	97
Tenga Vd. la bondad de enseñarme esto Tain'-ga oos-téd lah bon-dád day en-say-nyár-may és-toh	Mi mostri questo, scusi Mee mòstree kooèhsto, scoò-see	Montru tion al mi, mi petas Mohn'-troo tee'-ohn ahl mee mee peh'-tahs	98
Deseo comprar esto Des-sáyo com-prár és-toh	Vorrei comprare quello lì Vorrèhee compràhreh koo-èhllo leè	Mi deziras aĉeti tion Mee deh-zee'-rahs ah-cheh'-tee tee'ohn	99
¿Podria hallar aqui un libro conteniendo las curiosidades de esta ciudad? Pó-dreé-ah al-lyar' ah-kéy oon leé-bro con-tay-ne-en'-doh lahs coor-e-os-see-dáh-dehs day és-tah thew-dád?	Non c'è qui un libro che contenga le cose notevoli della città? Non chèh queè oon leèbro keh contèhn-gah leh còseh notèhvolee dèhllah chee-ttàh?	Ĉu estas tie ĉi libro pritraktanta la vindindaĵojn de la urbo? Cho ehs'-tahs tee'-eh chee lee'-broh pree-trahk-tahn'-tah lah vee-deen-dah'-zhohyn deh lah oor'-boh?	100

Travel concluded

Group 7

CLERKSHIP

14

Continued from page 1858

BANK ACCOUNT & CASH BOOK

Documents Connected with a Banking Account. Paying-in Books. The Cash Account. Notes on the Improved Form of Cash Book

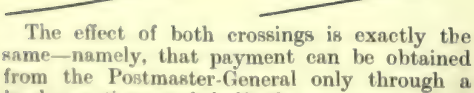
By A. J. WINDUS

AN allusion has already been made to variations in English and Scottish banking practice in relation to pass books. First let us note that in Scotland, as in England, the pass book is generally recognised as the *customer's* book. That being the case, lodgments are entered on the debit, and cheques on the credit side thereof, and the two sides harmonise with the two sides of the customer's cash book. Occasionally, however, the sides of the pass book are reversed so as to correspond with the customer's account in the bank ledger, where lodgments must appear as credits, and cheques paid as debits.

A Rare Pass Book. There is a third form of pass book—but this is more rarely met with—which has the usual columns for debit and credit entries, and a balance column besides. In the latter is shown the effect of each operation upon the banking account. That is to say, the pass book is balanced, item by item, but the balances are relegated to a special column or columns, and are not allowed to interfere with the continuity of the entries in the remaining columns of the pass book.

Next to be considered are the documents used in connection with a banking account. The chief of these are the "paying-in" slip and the cheque. The former is used when a lodgment is made. It shows for whose account money is paid in, the date, and the sum total, and tabulates the items comprising the lodgment, as bank notes, gold, silver and copper, town cheques —country cheques being paid in on a separate slip—postal orders, etc.

Crossed Postal Orders. Postal orders received by a person possessing a bank account are often treated as "crossed" cheques. If not already crossed by the senders, they are crossed by the receiver, who draws or stamps two parallel lines across the face of each order, with or without the addition of the words "& Co.," thus:



The effect of both crossings is exactly the same—namely, that payment can be obtained from the Postmaster-General only through a banker acting on behalf of a customer. The arrangement is a very convenient one for traders who receive a great number of small remittances. The peculiar feature of this system is that, while a cheque to order requires endorsement, and a postal order cashed for a private person must bear the signature of the payee, a postal order presented for payment through a bank needs neither endorsement nor signature of the payee.

When two or more postal orders are lodged at the bank, the total amount is entered on the town pay-in slip, and the details on a supplementary slip for the use of the bank.

"Paying-in" Books. Banks in England supply paper-bound books of pay-in slips to their customers. Each slip has a counterfoil. Particulars of the lodgment are entered on the counterfoil and repeated on the slip. The dividing line between the counterfoil and the slip is perforated, so that when the paying-in book is presented with the lodgment to the bank teller he may, after satisfying himself that all is in order, easily detach the slip from the counterfoil. The latter he initials, and hands back the paying-in book to the person who presented it, retaining the slip to be dealt with by the bank.

In Scotland the counterfoil paying-in book is dispensed with. The customer merely enters the items of the lodgment on the pay-in slip which he presents with the money and his *pass book*. Instead of initialling the counterfoil of the paying-in book, the teller, after verifying the slip, enters the amount in the pass book, in words as well as in figures, and initials the entry. The book and slip are handed back to the customer, who presents them to the cheque clerk. The latter compares the entry with the slip, initials the entry, and returns the pass book to the customer, retaining the slip to be dealt with by the bank. In some places it is the custom for the entry to be written in the pass book by the person making the lodgment.

Cheques Paid by the Bank. The other side of the pass book is concerned with cheques paid by the bank. In England, these are entered by the pass book clerk. In the metropolis, paid cheques are placed in the pocket of the pass book, and thereby reach the customer the next time he calls for his pass book from the bank. In Scotland, the customer himself enters the cheques in the pass book, and leaves the book with the bank now and again, so that his entries may be verified. In England, the pass book is in the bank's custody the greater part of the time, being withdrawn at intervals; in Scotland, it is seldom at the bank for any length of time, being required by the customer almost daily. By virtue of the system explained above, the Scottish pass book tends to become a copy of the customer's cash book rather than a copy of the customer's account in the bank ledger. Hence it is necessary, before striking the periodic balance in the pass book, to carry forward to next account all entered cheques which have not yet been presented for payment.

Paid cheques are treated with a certain amount of ceremony in Scotland, for there it is customary to send out a notice as follows:

Mercantile Bank of Scotland,
Glasgow,
January 6th, 1904.

Sir,

Your Current Account with this Office has been made up to 31st December, 1903, *at which date the balance due......you was £..........*
..........and I shall thank you to call at the Bank, at your earliest convenience, and docquet the ledger as correct, and receive paid cheques for year.

Yours faithfully,

The meaning of the word "docquet" in the foregoing notice may be best explained to readers by an illustration of its use in connection with a banking account—an extract from which is given below:

a *debit* balance, as in the accounts headed "Cash" and "Bank" respectively. In business, a credit balance on the latter is regarded as a bad sign, because it signifies an *Overdraft,* but a credit balance on cash account is ludicrous, since it implies that more money has been spent than has been received!

There are other reasons, however, why the cash account in the epitome cannot be held up as a model. One of them is that we are left in doubt as to the fate of cheque £10 16s. 3d. received from J. Bruce on September 28th. We know that Bevan and Kirk pass all receipts of cash through the bank, and yet we cannot find in the cash account any credit for the above amount; neither can we trace in the neighbouring bank account any debit for same.

The fact is, the journal entry recording the lodgment of Bruce's cheque at the bank is lacking. The omission must be repaired before the balance shown in cash account can be agreed with the actual amount of cash in hand. If the cash is balanced daily, as it should be, any such discrepancy as that indicated would be speedily brought to light; but sometimes cash is balanced weekly or even at less frequent intervals, and then an error may go undiscovered for an indefinite period. The use of the form of cash book shown on page 779 minimises the risk of omitted bank entries, for when an amount received is entered in the bank cash book, by that very fact the bank is duly charged.

Dr Adam Smith, Grocer, 117, George St. in a/c with the Mercantile Bank of Scotland, George St, Glasgow Cr

1904 Jan 1	To Order		15	9	1904 Jan 1	By Balance from last a/c as per docquet of acknowledgment of which the following is a copy: the above account examined and found correct vouchers given up, and the above balance of five shillings and seven pence is declared discharged being carried to a new a/c with the Mercantile Bk of Scotland		5	7
5	" Do	5	·						
7	" Do	11	4	2					
21	" Do	4	·	·					
22	" Do	20	·	·					
30	" Do	3	15	6	Jan 30	By Cash	33	10	
						" Balance	10	19	10
		£44	15	5			£44	15	5
	To Balance of a/c	10	19	10	Certified	Agent			

The epitome of ledger accounts at page 1750 is a continuation of the synopsis or birdseye view beginning at page 1751 and, hence, does not embrace accounts other than those affected by the (*a*) to (*u*) transactions, or items other than those dependent for their validity upon the journal entries located in another part of the synopsis. The ledger accounts as seen in the epitome are incomplete and, therefore, we need not be surprised at the accident of a *credit* balance, where we were entitled to expect

But the main objection to Account No. 1 in the epitome is that it confounds, under a common designation, transactions which are dissimilar. The first item on the debit side represents a withdrawal from the bank and an addition to the stock of ready money. The four remaining items represent receipts from outside sources which are lodged at the bank, and are not an addition to the stock of ready money. Yet all five items are entered in one column under the heading of receipts. Again, in this cash account there is but one column for the reception of amounts representing payments into bank (lodgments) and also for amounts representing actual expenditure. How easy it is under these circumstances for errors to creep in unawares may be judged from the fact that the credit item of £8 should not be in cash account at all, but should appear on the credit side of bank account—journal entry (*p*) being revised so as to read :

Wm. Bevan, Drawings a/c	Dr.	5 0 0	
J. J. Kirk Do.	Dr.	3 0 0	
To Bank			8 0 0

The Cash Account. The cash account, the source of whose entries was the journal, is now no more, its place having been taken by the cash book—an original register of receipts and payments. But the primitive *form* of the cash account is frequently perpetuated in the cash book. Two money columns, one on each side of the cash book, doubtless suffice for the entry of receipts and payments by traders and others who do not avail themselves of banking facilities.

Not only ordinary receipts and payments but also receipts and payments by the bank of moneys lodged and cheques drawn require registration in the cash book, and at this point the single debit cash column and the single credit cash column will be found inadequate to modern requirements. The most scientific method yet devised for recording cash and bank transactions has been explained on pages 977 and 779. But that method cannot succeed unless the rule as to lodging intact all moneys received from outside sources is rigorously enforced.

On various grounds some business men maintain they cannot adopt this system in its entirety. They are willing to pay into the bank all cheques received, and so much of the cash as may not be required for the till (petty cash), but they object to lodge all moneys without deduction as and when received. The question is, What is the proper method for recording cash and bank transactions in circumstances like these ?

We have seen that a cash book modelled on the lines of its forerunner, the cash account in the ledger, would be found insufficient for present-day needs. Assertion is not proof, however, and therefore a demonstration of the futility of the old form of cash book may be welcomed, and will now be given. The improved style of cash book in general use, where some, but not all, receipts are lodged at the bank will then be shown.

The table below comprises the cash and bank transactions of Harris, Green & Co., furniture dealers, for the week ended August 6th, 1904. The transactions are arranged in datal order, the petty cash expenditure for the week being summarised for the sake of convenience, and entered in one sum under the head of Trade Expenses. The cash book is balanced off weekly to guard against errors and omissions.

The adoption of single-column rulings on each side of the cash book will necessitate passing all discounts through the journal, cash and bank transactions being entered in the cash book as shown on the following page.

The student may find the following notes on the improved form of cash book useful.

1. In the earlier form of cash book, as shown, the bank balance has no place, and must be ascertained from the bank account in the ledger.

2. The rule is here to bank daily round sums of cash and all cheques received, but if a received cheque instead of being banked were to be paid away again or cashed it would be treated as coin, and entered in the " cash " column.

3. Rightly viewed, the cash in hand and the balance at bank constitute one fund divided into two parts, styled " cash " and " bank " respectively. The fund may be increased by cheques and cash received from outside sources, and it may be depleted by cash and cheques paid away. But the total fund can neither be augmented nor diminished by the improvement of one part of it at the expense of the other. If, then, the bank portion of the fund be added to by subtracting a like amount from the cash portion, a transfer has taken place, and should be recorded in the cash book. This has occurred four times in the case before us. Ticks have been

TABLE

1904		£	s.	d.
Aug. 2	Started the week with cash on hand	34	7	8
	Recd. cheque from King and Attwood in payt. of % £11 0s. 6d. less 2½% disct...	10	15	0
	Bank lodgment	40	15	0
	Cash sales	38	4	7
" 3	Recd. cheque from Jas. White and Co., and allowed disct. 8s. 8d.	16	16	4
	Bank lodgment	56	16	4
	Recd. from F. Warner, cash	1	4	3
	Pd. cheque to Fuller and Jones in settlt. of % £17 10s. (disct. 3¾%)	16	16	10
	Cash sales	29	19	6
" 4	Recd. cheque from St. George's Workhouse in settlt. of % as agreed	10	2	4
	Bank lodgment	40	2	4
	Recd. from Mrs. Reeves cash on %	5	0	0
	Cash sales	28	4	2
" 5	Mr. Harris drew from till on private %	20	0	0
	Paid cheque to Gosport Gas Co. for gas Midsr.	6	2	3
	Cash sales	31	5	5
" 6	Jos. Fordham remitted cheque £9 3s. 9d. in payt. of his % from which he deducted 4s. 9d. disct. ..	9	3	9
	Mrs. Reeves paid balce. of % in cash	2	4	7
	Cash paid away for wages	14	2	6
	Trade expenses for the wk. amtd. to	1	11	2
	Bank lodgment	39	3	9
	Cash sales	44	3	0

placed in the folio columns of the cash journal (or cash book) opposite the several transfer entries signifying that such entries need not be posted. The very fact of their duly appearing in the cash book is sufficient to adjust the cash and bank accounts as between themselves, in proof whereof we observe that the difference between the two "cash" columns is £48 19s. 6d. (£214 13s. 2d. – £165 13s. 8d.), which agrees with the balance previously obtained by a different method.

4. **Cash Sales.** In many retail businesses these form so large a proportion of the total takings that it is found expedient to insert an extra column on the Dr. side of the cash book for their reception. The daily totals of cash sales besides being entered in the cash column (or in the bank column if *all* moneys are paid into bank) are also recorded in the cash sales column. By this means, a separate total of the cash sales for a given period can be obtained. If the cash book is closed off monthly, the cash sales column would be ruled off every month, and the monthly totals posted to the credit of sales (or cash sales) account.

Continued

Old-style

Cash Book

Dr. August 1904

1904 Aug 2	To Balance	B/d	34	7	8
	" King & Attwood dis 5/6 (cheque)		10	15	
	" Cash Sales		38	4	7
3	" Jas White & Co dis 8/8 do		16	16	4
	" F Warner		1	4	3
	" Cash Sales		29	19	6
4	" St. George's Whse. cheque in full settt		10	2	4
	" Mrs Reeves on a/c		5	·	·
	" Cash Sales		28	4	2
5	" do		31	5	5
6	" Jos. Fordham dis 4/9 (cheque)		9	3	9
	" Mrs Reeves, bce of a/c		2	4	7
	" Cash Sales		44	3	·
	" Bank for cheques drawn during week		22	19	1
			£284	9	8
Aug 8	To Balance	B/d	48	19	6

Contra Cr.

1904 Aug 2	By Bank, paid in		40	15	·
3	" Fuller & Jones, dis 13/2 cheque		16	16	10
	" Bank, paid in		56	16	4
4	" do do		40	2	4
5	" Gosport Gas Co. cheque for Gas Meter qr		6	2	3
	" E Harris, Private a/c		20	·	·
6	" Wages		14	2	6
	" Trade Exps for week		1	11	2
	" Bank paid in		39	3	9
	" Balance carried down		48	19	6
			£284	9	8

Improved Cash Book

Dr August 1904

Date	Particulars	Fo.	Disc			Cash			Bank		
1904 Aug 2	To Balance	B/d				34	7	8	203	7	8
	" King & Attwood			5	6				10	15	·
	" Cash	✓							30	·	·
	" Cash Sales					38	4	7			
3	" J White & Co			8	8				16	16	4
	" Cash	✓							40	·	·
	" F Warner					1	4	3			
	" Cash Sales					29	19	6			
4	" St George's Whse in settt								10	2	4
	" Cash	✓							30		
	" Mrs Reeves, on a/c					5					
	" Cash Sales					28	4	2			
5	" do					31	5	5			
6	" J Fordham			4	9				9	3	9
	" Cash	✓							30	·	
	" Mrs Reeves, bce					2	4	7			
	" Cash Sales					44	3				
	forward			18	11	214	13	2	380	5	1

Contra Cr.

Date	Particulars	Fo	Disc			Cash			Bank		
1904 Aug 2	By Bank	✓				30					
3	" Fuller & Jones			13	2				16	16	10
	" Bank	✓				40					
4	" do	✓				30					
5	" Gosport Gas Co a/c Meter qr								6	2	3
	" E Harris, private					20					
6	" Wages					14	2	6			
	" Trade Exps for week					1	11	2			
	" Bank	✓				30					
	forward			13	2	165	13	8	22	19	1

Group 1
AGRICULTURE
14
Continued from page 1850

ENSILAGE

Preservation of Green Fodder in Silos. How to Build and Fill a Silo. Sour and Sweet Silage. Crops Suited for Silage

By Professor JAMES LONG

ENSILAGE, a word which is derived from the French *ensiler*—to seal up—is the process of preserving green fodder either in a stack or a properly constructed silo. The "silo" is a receptacle or apartment so built that the air cannot pass through its walls or floor, while the word "silage" is the material which has been preserved. Whether silage is stacked in the open or pressed in a silo, it is necessary to weight it heavily to exclude the air and thus to prevent excessive fermentation. Some twenty years ago the writer acted as one of the judges in the great silo contest conducted by the Royal Agricultural Society of England, and this experience, together with that obtained on the farms of M. Goffart, Baron Cottu, and Professor Lecouteux, three of the pioneers of the system in France, was sufficient to satisfy him as to the value of the system and of its simplicity when the principles which govern it are once understood.

Value of the Silo. The ensilage system was initiated in this country at a time when frequent bad seasons were accompanied by the destruction of large quantities of partially made hay, but since that date it has been comparatively little practised owing to better seasons, to the more extensive use of rapid haymaking machinery, and to the general preference of the farmer for hay. We do not, however, in England value the process as we should, inasmuch as it is adapted for the preservation of certain forage crops which are of extreme value in winter, and which cannot be systematically preserved in any other way. In the United States and Canada maize, which can be equally well grown throughout a large part of England, is preserved in the silo on a large scale for winter use. With us vetches, peas, lucerne, and trifolium incarnatum are well adapted to preservation in the silo, and if grown for the purpose, together with maize, they would materially add to the winter food supply. In some cases mixed grasses and clovers, cereals and pulse, have been preserved with great success, and the remark equally applies to the top of the Jerusalem artichoke, to sunflower stalks and heads, and maize chopped and mixed at the time of pitting.

Building and Filling a Silo. When the silo is properly filled and pressed, the fodder is practically kept in a sealed condition. Its walls must be smooth, and the bricks, where these are used, faced with cement, and finished with a steel float, while the corners should be rounded off so as to minimise the quantity of air retained. In filling, the process should be gradual, one layer being allowed to settle before another is brought in. The fodder should be well trodden, especially around the sides, with the object of compressing it as much as possible. It was at first supposed that grass and other green crops intended for silage could be cut and carted during any weather with equal success, but this is not the case. To fill the silo with fodder heavily wetted by rain is to court partial or entire failure.

Sour and Sweet Silage. The success of silage manufacture depends upon control of the temperature; but here it is necessary to explain that there are two classes of silage, the sweet and the sour, with their various gradations. If a silo, having been gradually filled and trodden from day to day, is finally pressed, whether by the aid of a mechanical appliance or by a dead weight, and pressure is applied too early, the result may be the production of sour silage. On the other hand, pressure being applied at a later period, the silage will probably be sweet, owing to the fact that heating or oxidation has intervened. In a word, if the temperature does not exceed 125° to 130° F., the silage will be more or less sour; whereas, if it reaches from 140° to 160° F., it will be more or less sweet. With the application of high pressure at an early period oxidation is checked, and the temperature fails to rise; whereas, if pressure is deferred, heating is encouraged, and the temperature rises to the degree already suggested. It must not, however, be allowed to go too far, or the result will be, as in the case of an overheated haystack, spoiled fodder, and consequent loss. Although there are many producers who make and even prefer sour silage, the production of which is almost unavoidable with the most succulent fodder crops, it is not to be regarded as a food for dairy cows, especially owing to its pungent odour, and to the fact that it is almost impossible to prevent it conveying a taint to milk.

Sweet Silage Most Nutritious. Sweet silage, which is more agreeable both in odour and flavour, is regarded as the most nutritious. Its sweetness is owing to the destruction of the organism to which acid fermentation is due. Grass silage contains from 71 to 72 per cent. of water, or slightly less than grass; while the soluble feeding materials, the albuminoids and carbohydrates, are slightly increased, the insoluble albuminoids and digestible fibre are decreased in quantity. Silage, and especially that which is sour, contains acetic and other acids, although the percentage varies with the temperature at which the fodder has been made.

As compared with hay, which loses considerable weight in the process of drying, the loss of weight as between grass and silage is much less considerable. In round numbers, while grass loses 20 per cent. of its weight during its conversion into silage, it loses 70 to 75 per cent. during its conversion into hay.

Crops Most Suitable for Silage. The colour of silage should be bright, and the flowers of the plants well preserved. Where, however, it is made at a high temperature, the colour deepens materially, until having passed 160° F. by several degrees, it becomes a deep brown, and thus resembles burnt hay. A good crop should never be preserved in a silo if it can be converted into hay. Silage has no market value whatever it may be worth on the farm, and although there is no ostensible reason why it should not be used for stock of various kinds as systematically as hay, there is greater risk in its production owing to general want of knowledge on the part of both farmers and workmen, while the loss which may follow the opening of a stack or silo, and consequent exposure to the air, is much greater than that involved in the opening of a hayrick. We cannot refrain, however, from emphasising the value of the system to those who are able to grow such foods as maize and vetches. In the preservation of maize, which may be grown at the rate of from 20 to 35 tons per acre, a silo is essential; while the fodder must be cut by a special machine, practically a large chaff-cutter, and packed as tightly as possible in an airtight silo.

GREEN MAIZE

Best Form of the Silo. A silo may be built in the form of a pit on the side of a hill for convenience in unloading and removing; it may be circular—a common plan in the United States—or it may be formed by running a wall across one end of any suitable and substantial building. A roof is essential, together with means of elevating the weighting material. Where a silo, having been gradually filled for more perfect treading and settlement, is ready for pressure, the fodder may be covered either with chaff or dried earth, which, if preferred, may be spread upon boards made to fit as closely as convenient, the object being to provide an even surface, and thus to ensure even pressure on the forage. In the absence of a mechanical press, bricks, bags of earth, or stones, blocks of concrete, or any similarly suitable material, may be placed on the top at the rate of 120 lb. to 200 lb. per square foot, the weight being increased with the depth of the silo and the quantity of forage it contains. It is a mistake to suppose that the ensilage process does more than preserve the material submitted to it. There are many who believe that the feeding value of silage is greater than that of the crop from which it has been produced. On the contrary, the value is slightly diminished, owing to the loss which follows heating, or oxidation. The successful preservation of such succulent crops as rape, mustard, mangel, or turnip-tops has, we believe, never been accomplished, and care should be taken never, unless as an experiment, to attempt to ensile foods which are practically foreign to the system.

Grass and other crops intended for silage should be cut when in bloom, and allowed to lie in the field sufficiently long to part with a small proportion of their moisture. In all cases the worst material, that cut around the hedgerows and roadsides, should be packed around the sides in the silo and covered over the top, for in both places there is usually a proportion spoiled.

Continued

87. MODERN GERMANY

THE GERMAN EMPIRE

Grouping of Mountains and Rivers around the Fichtel Gebirge. The Rhine Highlands. The German States. Climate. Products. North Germany. River Basins

Group 13
GEOGRAPHY
14

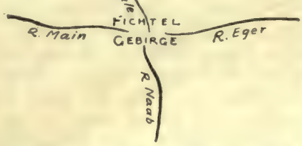
Continued from page 1839

By Dr. A. J. HERBERTSON, M.A. and F. D. HERBERTSON, B.A.

IN our view from the summit of the Alps, and again in tracing the course of the Rhine, we have seen something of the second great geographical feature of Europe—the Central Highlands. These are a broken system of forested mountains, nowhere rising above a few thousand feet, which stretch across Europe at the northern base of the Alps.

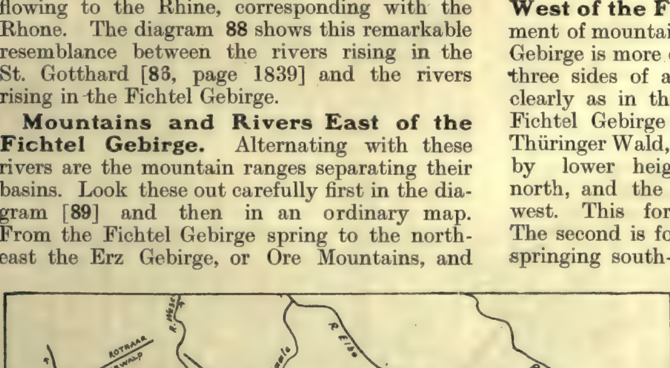
The Hub of the Central Highlands. We grouped the complicated topography of the Alps round the St. Gotthard mass and the mountains and rivers flowing from it. There is a similar point in the Central Highlands, a sort of hub from which mountains and rivers radiate like the spokes of a wheel. This is the Fichtel Gebirge, or Pine Mountains, clothed, as the name shows, with forests of pine. Look now at the rivers flowing from it, north, south, east, and west, to all four points of the compass [88]. They are: (1) To the north the Saale, the most important tributary of the Elbe, corresponding with the Reuss in the St. Gotthard series; (2) to the south the Naab, flowing to the Danube, corresponding with the Ticino; (3) to the east the Eger, flowing to the Elbe, corresponding with the Rhine; (4) to the west the Main, flowing to the Rhine, corresponding with the Rhone. The diagram 88 shows this remarkable resemblance between the rivers rising in the St. Gotthard [86, page 1839] and the rivers rising in the Fichtel Gebirge.

Mountains and Rivers East of the Fichtel Gebirge. Alternating with these rivers are the mountain ranges separating their basins. Look these out carefully first in the diagram [89] and then in an ordinary map. From the Fichtel Gebirge spring to the north-east the Erz Gebirge, or Ore Mountains, and to the south-east the Böhmer Wald, or Bohemian Forest, enclosing two sides of the diamond-shaped province of Bohemia, politically part of Austria. Between them and the Riesen Gebirge and Moravian Highlands, which enclose the two remaining sides, is the Elbe, flowing to the North Sea. Between the Sudetes and Moravian Mountains to the west and the Carpathian Mountains to the East is the important gap known as the Moravian Gate, with the Oder flowing north to the Baltic, and the March flowing south to the Danube. Compare these with the Saale and Naab farther west. The Vistula rises a little east of the Oder in the northern slope of the Carpathians, and flows across Russian Poland before it crosses the North German Plain to the Baltic.



88. RIVERS FLOWING FROM THE FICHTEL GEBIRGE

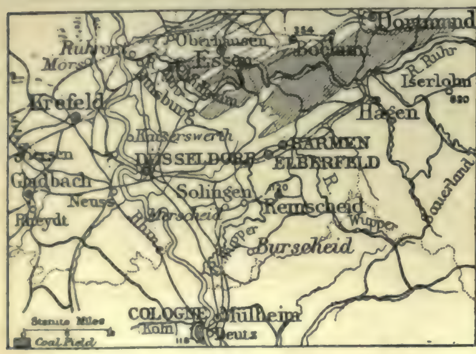
Build of the Country West of the Fichtel Gebirge. The arrangement of mountains and rivers west of the Fichtel Gebirge is more complicated. We can make out three sides of a western diamond, but not so clearly as in the case of Bohemia. From the Fichtel Gebirge to the north-west springs the Thüringer Wald, or Thuringian Forest, connected by lower heights with the Harz to the north, and the Vogelsberg and Rhön to the west. This forms one side of a diamond. The second is formed by the Franconian Jura, springing south-west from the Fichtel Gebirge, and continued by the Swabian Jura. At the western end of the Swabian Jura we have another important meeting-point of mountains and rivers, from which radiate, in addition to the Swabian Jura, the Rhine Highlands, running north, and the French Jura, running west. The last-named separate the Rhine from the Rhone, and connect the Central Highlands with the Alps. The rivers are the Rhine, breaking through the mountains and turning north at what we might call the Swiss Gate, and the Danube, flowing east, between the southern slopes of the



89. THE RELATION OF MOUNTAINS AND RIVERS IN CENTRAL EUROPE TO (a) THE FICHTEL GEBIRGE, (b) THE MORAVIAN GATE, AND (c) THE SWISS GATE

Central Highlands and the northern slopes of the Alps.

The Rhine Highlands. These have already been described, but here their connection with the rest of the Central Highlands is what we must be quite clear about. The Rhine has cut a wide valley across this broad eastern



90. THE RUHR COALFIELD

part of the Central Highlands, dividing them into the Eastern and Western Rhine Highlands. These are again broken up by the tributaries coming in from east and west. This gives us on the east the Schwarzwald, or Black Forest, the Odenwald, the Taunus, and the Westerwald. On the west are the Vosges, opposite the Black Forest, the Haardt, opposite the Odenwald ; the Hunsrück, opposite the Taunus ; and the Eifel, opposite the Westerwald. The Eifel and Westerwald represent the third side of the western diamond.

On the east, the Neckar comes in between the Black Forest and Odenwald, the Main between the Odenwald and Taunus, and the Lahn between the Taunus and Westerwald. On the west the rivers coming down between the Vosges, Haardt, and Hunsrück are unimportant, the only considerable western tributary being the Moselle, between the Hunsrück and Eifel. The relation of all these highlands to each other is shown in the map or in the diagram [89], which is a sort of skeleton key to the ordinary map.

THE GERMAN EMPIRE

What Germany is Politically. The German Empire (209,000 sq. miles) dates only from 1871. The German Emperor, who is not Emperor of Germany, is the King of Prussia, the largest of the many independent States which make up the German Empire. With Prussia are united for political, military, and fiscal purposes the three kingdoms of Saxony, Bavaria, and Würtemburg, six grand duchies, many duchies and principalities, and the free cities of Lübeck, Hamburg, and Bremen. All these are independent in their internal relations, and all but the cities have hereditary rulers who rank among the royal houses of Europe.

What Germany is Physically. In a geographical sense South Germany consists of the Alpine foreland from the Swiss Gate to the valley of the Inn, a tributary of the Danube. In the west the frontier follows the crest of the Vosges, the valley of the Moselle for a short distance, and then runs roughly north. In the east it is more definitely physical, and is determined by the Böhmer Wald, Erz Gebirge, Sudetes, and the mountains beyond the Oder. Then it crosses the featureless plain in an irregular line trending considerably to the north-east. South Germany thus consists of the Central Highlands, and North Germany of the plain to which they slope.

Climate. We can deduce the general character of the German climate from our knowledge of the climate of Europe. In summer the isotherms will approximately follow the parallels of latitude, in winter they will cross them almost at right angles—that is to say, the south will be warmer than the north in the valleys in summer, but there will be very little difference in winter. Then the difference will be between the east with a severe winter, and the west with a mild one.

All this is true, but we want a little more detail. Take the January isotherm of 32° F., indicating frost. The Rhine basin lies outside it, and has mild winters and early springs. The isotherm enters Germany at the mouth of the Weser, and runs nearly due south through Munich. East of it the winters are long and severe, and spring late. The isotherms of 30°, 28°, 26°, indicate increasing severity of frost, so that we can readily understand how much more intense the winter cold becomes as we go east. "In the Rhine district, when the swallows return and the almond and apricot blossoms are opening, snow is still lying in east Prussia, where the frost does not break up till

91. INDUSTRIAL REGION OF SAXONY AND SILESIA

the middle of March." Another consequence of the severe winters in the east is that the Baltic ports are closed by ice in winter, while those of the North Sea are open.

The summer climate of North Germany is very much that of the Thames basin, both having an average July temperature just over 62° F. South Germany is warmer. The July isotherm of 64° passes near Mainz, curves a little south, and oscillates round the parallel of 53°, south of which the summers are warm in the valleys, especially in those of the Rhine and its tributaries.

Products. Magnificent forests cover the mountains of South Germany and parts of the northern plain, in all about one-quarter of the surface of the country. About one-half is under cultivation, the most fertile part being the Upper Rhine plain, the Garden of Germany. Here the vine comes to perfection, yielding famous wines. Its northern limit is about that of the warm summers, lat. 53°. In the east the winters are too severe for it. Much wheat is grown in the Rhine plain, but in most other parts rye is the chief cereal. The potato is grown in enormous quantities in North and Central Germany, and a coarse spirit, sold as brandy, is made from it. The sugar-beet is important in the same districts. Hops are grown chiefly in Bavaria, the beers of which are famous.

Mineral Wealth. We have seen that Germany has an important coalfield, the Westphalian field, mainly in the Ruhr valley, at the northern margin of the Central Highlands [**90**]. Other coalfields occur in similar positions—(1) the Saar field, on the Saar ; (2) the Saxon field, north of the Erz Gebirge, drained by tributaries of the Elbe ; and (3) the Silesian coalfield, between the Oder and the Vistula [**91**]. Iron is found near most of them. Other minerals are abundant in the Central Highlands, one part of which is called the Erz Gebirge, or Ore Mountains.

The Rhine Provinces. From Basle to Karlsruhe the Rhine flows between the Grand Duchy of Baden on the west and the Imperial provinces of Alsace and Lorraine, annexed from France in 1871, on the west. From Karlsruhe to Mannheim the western bank belongs to the Palatinate, politically part of Bavaria. From Mannheim to Mainz the river flows through the Grand Duchy of Hesse, and from Mainz to the Dutch frontier it is in Prussia. The kingdoms of Würtemberg and Bavaria, east of Baden, are partly in the Rhine basin and partly in that of the Danube.

The Other River Basins of Germany. The rest of Germany consists of the whole or part of the basins of the Ems, Weser, and Elbe, flowing to the North Sea, most of the basin of the Oder, and parts of those of the Vistula and Memel or Niemen, flowing to the Baltic. Before describing them a word must be said about the plain of North Germany, so different from the forested highlands of South Germany.

The North German Landscape. North Germany consists of two belts. The south is a low plain, sloping from the Central Highlands ; while the north is broken by wooded hills, forming the Baltic Heights. Much of both is moorland or *heide* (heath), poorly watered, and covered with heather or coarse grass. Only the sheep and the bee thrive, and villages are consequently few and population scanty. Along the coast in the west is a belt of marshy but fertile alluvial land, consisting of deep soil, without a stone, formed of the sediment brought down by the rivers. When drained it makes rich pastures. Population centres round any little height, on which are built churches and farmhouses, the latter with moats, and approached by bridges. They look out over a

92. ESTUARY OF WESER AND ELBE

wide expanse of grass lands and cornfields, drained by innumerable canals. Seawards, the view is bounded by the dam, " beyond which extends a tract browsed only by sheep, and traversed by a network of salt sea runs."

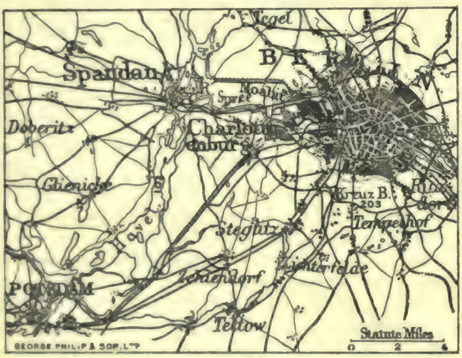
The Baltic Lakeland. The map of Germany east of the Elbe shows the character of the region. It is dotted with thousands of lakes, set among pine-woods, with irregular wooded heights—the Baltic Heights—rising above them.

The North German Coast. This has been aptly compared to a tattered lace fringe, especially east of the Jutland peninsula. Here the rivers flow to fresh-water *haffen*, or lagoons, almost landlocked by broad sand bars. In the North Sea, where the strong tides carry the sediment out to sea, the rivers form estuaries.

The Ems and Weser Basins. The Ems rises in the Teutoburger Wald, an outlier of the Thuringian Highlands. It flows north through a marshy country to the North Sea, with Emden as its estuary port. Separated from it by the Teutoburger Wald is the Weser, formed by the union of the Fulda from the Rhön, and the Werra from Thuringia. It leaves the highlands by the gap known as the Westphalian Gate, affording a railway route. It flows across marshy country to the North Sea with the great port of Bremen at the head and Bremerhaven at the mouth of its estuary. The naval station of Wilhelmshaven is on the Jahde Bay just west of the Weser estuary [**92**]. South of the Ems are the industrial towns of the Ruhr coalfield [**90**]. Between the Ems and Weser

is Bielefeld, the centre of the German linen manufacture. To the Weser flows the Aller, on tributaries of which are the fine old towns of Hanover, Hildesheim, and Brunswick. These tributaries drain the wooded Harz, rich in minerals, the highest point of which is the Brocken, famous in legend. Picturesque old towns, with fine timber houses, are built at the mouth of the Harz valleys, many engaged in mining. The free city and port of Bremen owes its prosperity to the deepening of the Weser. It has a large import and export trade, and manufactures many raw materials brought to its docks.

The Elbe Basin. The Elbe rises in the wild Riesen Gebirge, part of the Sudetes, and receives many tributaries in Bohemia. On the largest of these, the Moldau, is Prague, the capital of Bohemia. The Elbe enters Germany between the Sudetes and Erz Mountains, flowing through the district of Saxon Switzerland, with bottomless ravines and isolated flat-topped hills. At the north end of its gorge is Dresden, the capital of Saxony, with famous art treasures. The tributaries of the Elbe drain the Erz, Thuringian, and Harz Mountains. The largest is the Saale, from the Fichtel Gebirge, with Leipzig, the great printing and publishing city, on a tributary, and the salt



93. BERLIN AND ITS SURROUNDINGS

town of Halle on the main stream. The Saale flows through a region rich in timber and sheep pastures, which supply the famous Saxony wool. This, with the minerals of the Erz, is manufactured on the Saxon coalfield, in the busy district round Chemnitz. Below its confluence with the Elbe, which has flowed through the potato and sugar-beet district, is Magdeburg, a great fortress, and the centre of the Elbe sugar manufacture. To the east the country is marshy and studded with lakes round Berlin, the capital of Prussia, on the Spree, which flows to a tributary of the Elbe. Berlin is a magnificent modern city, in the centre of the North German plain, with excellent canal and railway communication and numerous industries [**93**].

Hamburg. At the head of the Elbe estuary is the port and free city of Hamburg, the greatest commercial town in Germany, doing an immense trade with all parts of the world. Its imports are very varied. Its exports show the character of the Elbe basin. They include iron and machinery, textiles, woollens and worsteds, glass, cattle, cereals and timber. Altona, in Prussia, is now practically part of Hamburg. Cuxhaven is a port at the mouth of the estuary, belonging to Hamburg, opposite to which is the island of Heligoland, once British [**92** and **87**].

The Kiel Canal. Below Hamburg the Elbe estuary is connected by a ship canal with Kiel, giving a direct route from the North Sea to the Baltic Sea, without going round Denmark. Both Kiel, therefore, and Lübeck, a free city and port south of Kiel, are, in a sense, ports of the Elbe, to which indeed Lübeck is joined by the Trave Canal.

The Oder Basin. The Oder also rises beyond the frontier of Germany, which it enters at the Moravian Gate. It flows north-west across the plains of Silesia and the Baltic Lakeland, through a region producing rye, sugar-beet and timber. Round its upper course are the Silesian coalfields, where Breslau manufactures wool from the sheep pastures of the Central Highlands, linen from local flax, and cotton. Sugar-making is important in and around Frankfurt-on-the-Oder, which must not be confused with the town of the same name in the Rhine basin. The Oder enters the Stettin Haff. Its port, Stettin, is connected by canal with Berlin.

The Vistula and Memel Basins. Only the lower courses of these rivers are German. Danzig is the port of the Vistula, and manufactures much of its produce. Among such industries are woollens, paper-making, shipbuilding (timber), distilling (cereals). Königsberg is the port of the short Pregel, and Memel, at the exit from the Kurisches Haff, is the port of the river Memel or Niemen.

Continued

ANCIENT & MODERN ROADS

Main, Rural, and Private Roads. Regulations for Quarries, Pits, and Pavements. Stopping and Diverting Highways. Road Sanitation. Maintenance

Continued from page 1828

By A. TAYLOR ALLEN

WHETHER in ancient times better roads and pavements were built than at present, or whether only the best ones remain, is uncertain; but it is certain that some of the remains of such structures found in Rome, for instance, evince engineering skill of high degree. These were laid out carefully, excavated to solid ground, or, in swampy places, made solid by piles. Then the lowest course was of small-sized, broken stones, none less than 3 in. or 4 in. in diameter; over these was a course, 9 in. thick, of rubble or broken stones cemented with lime, well rammed; over this a course, 6 in. thick, of broken bricks and pottery, also cemented with lime; upon this was laid the *pavimentum*, or pavement, composed of slabs of the hardest stone, joined and fitted together as closely as possible. This was costly—the Appian Way, extending from Rome to Capua, a distance of about 130 miles in length, having almost exhausted the Roman treasury—but it was as enduring as Nature's own work. In Peru and Central America similar remains, 1,000 to 2,000 miles long, were found by the Spaniards, which, as Prescott says, were built of heavy flags of freestone, and, in some parts at least, covered with a bituminous cement which time has made harder than stone itself.

Private Paths. In the very early periods of English civilisation the tract across the heath and the moor sufficiently answered their purpose. Yet, even in those districts unencumbered with wood, where the first settlements were made, stone tracts were laid down by the tribes between one village and another. Formerly no attempt was made to build a road, and most of the old English roads owe their present lines to particular circumstances—many of them were, doubtless, originally footpaths; others, perhaps, the tracks of the aboriginal inhabitants, these becoming the most convenient horse paths (referred to on maps as *bridle-paths*). According as the lands of the kingdom were appropriated, the lines of road became fixed and unalterable, there being no other legal lines left for carriage roads, which accounts for the singular way in which many of our existing roads turn and twist in an apparently inexplicable manner. In the neighbourhood of London there was a *hollow way*, which now gives its name to a populous metropolitan district. Hagbush Lane was another of such roads. Before the formation of the Great North Road it was one of the principal bridle-paths leading from London to the northern parts of England; but it was so narrow as barely to afford passage for more than a single horseman, and so deep that the rider's head was beneath the level of the ground on each side.

Early English Roads. In 1346 Edward III. authorised the first toll to be levied for the repair of roads leading from St. Giles in the Fields to Charing Cross (then a village), and from the same quarter to near Temple Bar. The footway at the entrance of Temple Bar was impeded by thickets and bushes, and in wet weather almost impassable, and the roads westward were so bad that when the sovereign went to Parliament, faggots were thrown into the ruts in King Street, Westminster, to enable the royal coach to pass along.

The first Act for paving and improving the City of London streets was passed in 1532.

The first turnpike road established by law was in 1653; this was made for taking toll of all but foot-passengers on the northern road through Hertfordshire, Cambridgeshire, and Huntingdonshire.

No very considerable improvements in the art of road-making took place till the Highland Rebellion of 1745, which gave a great impetus to the construction of roads for military as well as for civic purposes, as is evident from the fact that from 1760 to 1774 no fewer than 452 Acts regarding making, repairing, and improvement of highways were passed.

Macadam. Mr. John London Macadam, the great road-maker, was born on September 21st, 1756. During the early years of the nineteenth century he was travelling about the kingdom making inquiries into the systems of road-making. By August, 1814, he had travelled 30,000 miles, and had spent from his own private resources a sum equal to £5,019.

In 1823 he succeeded in getting an inquiry before a committee of the House of Commons as to his system, and had made a set of road-making implements, so that he might the more clearly explain the principles he advocated, and in 1825, having proved an expenditure of several thousand pounds from his own resources in carrying out his improvements, this amount was reimbursed to him by the Government, together with an honorary tribute of £2,000.

Mr. Macadam's system of road-making, to use his own term, was "to put broken stone upon a road which shall unite by its own angle so as to form a solid, hard surface." His practice was to lay flints or some other hard material broken to a uniform size of approximately cubical shape, 1½ in. to 2 in. in diameter to a depth of 10 in., the only preparation being the levelling of inequalities and the digging of side drains, the broken material being spread evenly over the road surface and left to be consolidated by the traffic. He used no admixture of binding material,

and the stones were perfectly clean. This rule of Mr. Macadam, which in theory appears all right, in practice is found absolutely impossible to accomplish.

Telford's Highland Roads. About the same time that Macadam was busy engaged in his system of road-making and repairing, another pioneer, Mr. Telford, was equally busy constructing many miles of roads in the Scottish Highlands, but on an entirely different system. Mr. Telford did not believe it possible to construct a hard road by simply laying 10 in. of broken stones upon a soft natural foundation, his method being to keep the broken stones from the subsoil, and to ensure this he first laid down a "pitched foundation," consisting of pieces of stones or other hard substance placed upon the level bed by hand to form a close, firm pavement, and upon this foundation was laid a thickness of broken road metal.

Main, Rural, and Private Roads. The highways of England and Wales are divided among some 2,000 local authorities. All roads which had been dis-turnpiked between December 31st, 1870, and August, 1878, or were subsequently dis-turnpiked, became *main* roads under the Highways and Locomotive (Amendment) Act, 1878. Some of the existing roads or portions of roads although dignified by the term "main," are not "principal" roads, but being old turnpike roads, whose days of importance have passed away, have now very little traffic on them. By the Local Government Act, 1888, County Councils, who were previously only contributing authorities, were charged with *entire* responsibility of the maintenance of all main roads. In the provinces public highways are managed by City, Town, and Urban District Councils, while in the country they are managed by Rural District Councils.

Prior to 1835, so long as there was an intention on the part of the owner of the soil to dedicate a road to public use, which he signified by throwing open a road unreservedly, and an acceptance by the public signified by the using of the road, the two circumstances suffice to make a road a public highway; but now roads and streets remain private—*i.e.*, not repairable by the inhabitants at large—until they are formally dedicated to the public [see also under New Streets and Footpaths—Dedication as Public Highways].

Breaking Up. The opening of roads for the laying of new mains, repairs to existing ones, or other public services, is a continual cause of complaint, and one of the stock grievances of the public, and the damage caused to highways by openings made in them by builders, owners, and occupiers of property, and by gas, water, and other companies, is a source of much reasonable irritation and annoyance to Local Authorities who are responsible for their maintenance. A macadamised road opened for the construction of a trench can never be properly reinstated without showing some evidence of it, even when the replacement has been carried out by experienced roadmen; where, however, other workmen have been employed, as those engaged by builders or house owners, the damage is greater. The ramming of the materials in refilling the trench is most rarely executed in a sufficient manner; and instead of two men ramming being employed to one filling, which is necessary, and the materials being replaced in layers of not greater thickness than 6 in., ramming is generally performed in a most perfunctory manner—the material is replaced in large lumps, and as a consequence the trench subsides for weeks after. The substance of the sections giving statutory powers are collected into a short compress and in direct sequence.

Powers to Open Roads. The Gasworks Clauses Act, 1847, empowers the undertakers to open and break up any road, and lay down and place pipes, conduits, service pipes, and other works, and from time to time to repair, alter, or remove the same, subject to three clear days' notice being given to the clerk, surveyor, or other officer of the Local Authority before beginning such work.

The Waterworks Clauses Act, 1847 (incorporated with the Public Health Act, 1875, Sec. 57) provides similar power, and Sec. 52 gives power to a private individual to open or break up so much of the pavement of any street as shall be between the water-main and his house, building, or premises, after giving due notice. It has been decided by the courts that the word *pavement*, as used in this section, is not confined to the footpath only. Provisos are also contained in the Tramways Act, 1870; the Railway Clauses Consolidation Act, 1847; the Electric Lighting Act, 1882; Forrest Fulton's Act (the commonly known title of the Water Companies Regulation of Powers Act, 1887); and the Telegraph Acts, 1863, 1873, 1878, 1892.

Quarries, Pits and Pavement Regulations. Where any quarry dangerous to the public is in open or unenclosed land within 50 yards of a highway or place of public resort dedicated to the public, and is not separated therefrom by a secure and sufficient fence, under the Quarry Fencing Act, 1887, the Local Authority has power to deal with it. The term *quarry* includes every pit or opening made for the purpose of getting stones, slates, lime, chalk, clay, gravel, or sand, but not any natural opening.

The following can be dealt with by Local Authorities as obstructions in streets:

(*a*) Shop and sun blinds if fixed less than 8 ft. in height.

(*b*) Trees overhanging roadways.

(*c*) Doors and gates opening outwards on the pavements.

(*d*) Defective rain-water shoots from buildings.

Where the Local Authorities do not undertake or contract for the cleansing of footways or pavements adjoining any premises, they may make bylaws imposing this duty on the occupier of any such premises. This is the substance of an important provision in the Public Health Act, which may place occupiers under some responsibilities which have not, perhaps, been

considered. Yet there is ocular evidence on the pavement day by day, opposite most greengrocers' and butchers' shops, of negligence in this matter. By the Public Health (London) Act, 1891, the City householders were relieved of this duty, which was thereupon cast upon the Sanitary Authority.

Stopping and Diverting Highways. It is the duty of a District Council, whether it be the Highway Authority or not, under the Local Government Act, 1894, to protect all public rights of way and to prevent, as far as possible, the stopping or obstruction of any such right of way, whether within their district or in an adjoining district in the county or counties in which the district is situate, where the stoppage or obstruction thereof would, in their opinion, be prejudicial to the interests of their district; and they may, for the purpose of carrying into effect the section, institute or defend any legal proceedings, and generally take such steps as they deem expedient.

Recovery of Public Rights. This section applies not merely to future obstructions or stoppages of rights of way, but to any past obstructions or stoppages which have been effected in recent times; and where there is clear evidence that the public have in past times enjoyed such rights the District Council will be entitled to take proceedings for the purpose of recovering them, or of putting an end to the obstructions. It is not necessary, however, to point out that it will not be expedient to rake up cases which have long been allowed to pass unquestioned; for, although there is no limit of time to the enforcement of public rights, there may be difficulty of proof in respect of rights which, in fact, have not been exercised for a length of time.

The Act also provides that where a Parish Council has represented to the District Council that any public right of way within the district, or an adjoining district in the county or counties in which the district is situate, has been unlawfully stopped or obstructed, it shall be the duty of the District Council, unless satisfied that the allegations of such representation are incorrect, to take proper proceedings accordingly.

Action by Public Councils. If the District Council refuse or fail to take proceedings in consequence of such representation, the Parish Council may petition the County Council of the county within which the way is situate, who are then empowered to take such proceedings as the District Council might have done. In view of this provision it will be necessary for the District Council to inquire carefully into any such case of obstruction or stoppage which is brought before them by a Parish Council, and to take action upon it, if it should be clear to them that the right of the public has been infringed. It may, however, be pointed out that the duties of a District Council are not limited to cases where they are set in motion by a Parish Council, but that, in any case where it is brought to their notice from any quarter that a footpath has been obstructed or stopped, it will be their duty to take steps to vindicate the right of the public, if fully satisfied of the validity of the claim.

These observations apply equally to bridleways as to footpaths. It not infrequently happens that the right of the public to use a way for horses is questioned, while that of its use for foot passengers is admitted. In cases of bridleways it will be the duty of the District Council to assert the right of the public to use the way for horses.

Proceedings by District Council. With respect to the proceedings to be adopted by the District Council where they are clearly of opinion that a footway or bridleway has been obstructed or stopped, there appears to be three courses open to them: (1) To direct the removal of the obstruction; (2) to indict the person who has caused the obstruction for a misdemeanour; (3) to proceed by way of action in the name of the Attorney-General, for which his "fiat" must be obtained in the usual way.

The last of these courses will, in many cases, be found preferable to that of indictment. As a general rule, however, where the public right appears to be quite clear, it will be better for the District Council to direct their surveyor to remove the obstruction to a footpath, leaving it to the person who has placed it there, if he wishes to raise a question of law, to do so by bringing an action of trespass. This course should be adopted only after due notice to the parties concerned.

Grounds for Stopping a Footpath. With respect to the legal diversion or stoppage of footpaths, it is to be observed that under the Local Government Act, 1894, the consent of both the Parish Council (or of the Parish Meeting where there is no Parish Council) and the District Council is necessary before justices in Quarter Sessions can give their sanction to such a course. The only ground on which a footpath can be wholly stopped without the substitution of another is that it is unnecessary, and this question will be for the consideration of both the Parish and the District Councils. Where it is proposed to divert a footpath, the question for consideration will be whether the proposed footpath is more commodious for the public than the existing footway [See Highway Act, 1835, 5 & 6 Will. 4, c. 50, secs. 84-92.]

The District Council may refuse their consent to the stoppage of a footpath even after the Parish Council has given consent.

Rights of Landowners. The owner of the land over which a public footpath lies has the right to maintain existing stiles or swing gates across it, provided they are of a reasonable kind, and are such that the public are not debarred from the use of the footway. But it will be the duty of the District Council to see that the use by the public of a footpath is not hindered by the erection of stiles or gates which are substantially less convenient than have existed in the past.

Now that our carriageways are being converted more or less into motor and engine tracks, the solitude of these paths forms a most pleasing contrast to the danger and flurry to

which our highways are subjected, and it is a matter which reflects very severely on highway authorities that in many cases they take no steps whatever to prevent these footways and bridle-paths being closed, many of which are so overgrown with trees as to be perfectly useless.

Road Sanitation. The sanitation of roads is a question which has not received, by scientific and practical investigation, the attention as to its influence upon health demanded by its importance.

Dust from street surfaces contains bacteria generated from the excretal and other organic and vegetable matter which are more or less injurious to the throat, lungs, and eyes. The menace to health by the fouling of the surfaces of the roads of our cities and towns is an established fact, and this is now combated by scavenging and watering at a very considerable cost to the community.

In 1856 when the Metropolis Local Management Act came into operation there were no asphalt or wood-paved roads; steam-rollers were unknown, and the mud was up to one's ankles on a wet day.

Street Cleaning. The Public Health Act, 1875, contained provisions for the proper cleansing and watering of streets. The Public Health (London) Act, 1891, made it compulsory for every sanitary authority to employ a sufficient number of scavengers, or contract with any scavengers, for the execution of the duties of the authority under this act with respect to the sweeping and cleansing of the several streets within their district, and the collection and removal of street refuse.

Street sweeping by rotary brush machines drawn by horses is found to be 33 per cent. cheaper than if done by hand. It might be expected that, where streets have been paved to a very even surface with wood or asphalt, they should be kept much cleaner than they are, but the difficulty is that not only is mud and dust produced by the droppings on any particular street under observation, from the sanding that it receives to reduce slipperiness, but there is also a large amount of dirt from adjoining streets transferred by the wheels of vehicles; and in any wide-jointed paving such as granite setts, it is surprising what an amount of mud may be retained in the joints after the surface has been as effectually cleaned as ordinary processes can make it, for as soon as traffic begins to run over a road just swept, horses' feet and wheels at once begin to disturb the mud from the joints, and it soon appears as if nothing had been done to clear it.

Cost of Cleaning. Macadam must head the list as the most costly for cleansing; next to that granite paving must be placed. Very close after this comes soft wood, the disintegration of which is very rapid, and the spongy nature of its surface assists to accumulate mud. Hard wood paving can be placed at a considerable distance below soft wood, for if paved with close joints its surface is almost impervious, and it is easily cleaned. The road material costing the least for cleaning is asphalt.

Taking the whole of London within the limits of the London County Council and including the City to have just under 2,000 miles of streets, estimating the material to be removed on the present average of 980 cubic yards per mile, 2,000,000 cubic yards is removed per annum for the whole of London.

In comparing the cost of the work as done in European cities with New York, enormous discrepancies exist, but this is apparently due to the difference in wages. In Vienna, for instance, a sweeper works 10 hours for 1s. $8\frac{3}{4}$d. In New York he gets 9s. 7d. for eight hours work. A mile of average streets in New York has been reported to cost—without including the treatment of snow—between £1,400 and £1,500, while in London the cost for the same work is between £240 and £260.

A large amount of the expense is accounted for by the droppings of the horse and the deteriorating influences of its hoofs.

With the introduction of motor vehicles, accumulations in centres of dense population will no longer assault our olfactory nerves and reduce our vitality by putrescent emanations, and the disintegrated fœcal matter, which is now pounded under the traffic, will no longer be distributed on the breeze to irritate pedestrians and poison exposed food-stuffs.

Maintenance. For economial and convenient traction, roads should be maintained in thoroughly good order. Roads well maintained cost less than bad roads. Experience proves that a road with sufficient strength, good surface, and thorough drainage, can be kept in first class order with a smaller quantity of material than an inferior, ill-kept road.

The cost of maintaining a macadamised road as compared with that of granite setts has been said to be as high as 5 to 1, and that this cost, if capitalised for 12 or 13 years, will equal the first expense, interest on money, and the necessary repairs for a granite-paved road.

Description of Pavement.	First cost of laying complete, per square yard.	Approximate annual cost of maintenance per square yard.	Cost of scavenging per square yard per annum.	Average Life.
	s. d. s. d.	s. d. s. d.	d. d.	Years.
Asphalt (compressed) ..	15 0 to 18 0	1 2 to 1 9	4 to $4\frac{1}{2}$	18
Granite setts ..	16 0 to 17 6	5 to 9	$2\frac{1}{2}$ to 3	20–25
Macadam ..	3 6 to 5 0	1 9 to 3 0	10 to 12	2–3
Hard wood blocks ..	15 0 to 16 0	10 to 1 3	2 to 3	14
Creosoted deal blocks ..	9 6 to 11 0	1 0 to 1 6	2 to 3	8

The ancient method employed to meet the expenses for repairs and maintenance of the roads until after the restoration of King Charles II. was by a £1 rate on the landholders in the respective counties, and by the supply of carts and horses by parishes for a limited number of days. And in France they were, down to 1764, maintained by statute labour.

Continued

A SHORT DICTIONARY OF CIVIL ENGINEERING

See also A Short Dictionary of Building Construction, page 310

ABUTMENTS—Masses of masonry or natural rock, upon which the ends of a bridge are supported.
Adit—Subterranean passage or gallery.
Air-lock—Chamber with ingress and egress doors for workmen passing into workings where water is excluded by pneumatic pressure.
Ajutage—Tube fixed at the mouth of a hydraulic vessel to regulate water discharge.
Alignment—The setting of two or more planes, or three or more poles or points, in one straight line.
Alternate stresses — Stresses by which structures, or parts of structures, are placed alternately in tension and compression, as in counterbraced structures, subject to moving loads.
Anchor and Collar—Hinges employed in hanging lock gates.
Apron—A protection of concrete or other material to prevent the scouring effects of running water.
Ashlar—Blocks of stone cut to regular shapes, generally rectangular.
Attle—Any rubbish or stony matter.

BALANCE BOX—Box which counterbalances the load lifted by a crane, usually a cast-iron box loaded with small weights.
Banker—Bench or table on which masons prepare and shape their materials.
Bare—A term which signifies that a dimension is very slightly under the size preceding the term.
Barrage—The barring of a river or other watercourse to bank up the water behind.
Barring engine—An engine used for the initial turning of larger engines.
Barrow—Receptacle for carrying earth, etc.
Bascule—A bridge lifting in two leaves hinged to the abutments.
Bat—The half of a brick.
Battens—Sawn pine timber measuring not more than 7 in. by 2½ in. in cross section, or not less than 6 in. in width.
Batter—Face of a retaining wall when built in a leaning position.
Bay—In a lattice girder the space included between two adjacent apices is called a bay.
Beaumonteque (baum-antik) — Any mixture for stopping holes in stone or woodwork.
Beetle—Wooden mallet for driving small piles.
Benches—Platforms about 6 feet in width on the sides of cuttings.
Benching—Is cutting steps in the sloping surface of earth before filling-in behind a retaining wall.
Bench-mark—A recorded point in a survey, either marked on the ground or described in the field book or level book.
Berm—Narrow strip of level ground along the face of a slope.
Betty—An iron rod used as a crowbar.
Bight—The hanging loop of a chain or rope which falls below the pulleys in lifting tackle.
Block and fall—The rope tackle used in lifting heavy loads.
Bollard—Post of cast iron or timber, largely used for mooring vessels.
Bolster—Short piece of wood interposed horizontally between head of post and supported beam.
Boning Staff — Upright rod with a cross bar at right angles; used for levelling.
Bonnet—Hole formed in iron pipes and fitted with lid.
Boom—A term applied to the mast or girder of a derrick crane.
Booms—Pieces of timber connected with fender piles to protect coffer-dams.
Bowstring girder—A girder in which the outward or horizontal thrust of a curved beam is sustained by a horizontal tie beam forming the chord of an arc.
Braces—Diagonal pieces used in the centre portion of a truss.
Break-up — Excavation commenced from an underground passage or gallery and carried upwards.
Breast wall—A wall at the foot of an embankment cutting off the toe, or any wall breast high.
Broach—A boring tool, employed for the purpose both of enlarging and imparting accuracy to tapered and parallel holes.
Brob—Wrought-iron spike driven into bars or sills, around the ends of props, to steady them.

CAISSON—Water-tight enclosure built up as required to surround foundations under water.
Camber—The bow or upward convexity of material to allow for sinkage.
Cantilever—A beam fixed at one end and loaded at the other end or loaded uniformly.
Cess — The space between the top of a railway embankment and the boundary fence.
Check—A joint composed of two portions, male and female, fitting one into the other, and so forming a guide or steady.
Chute—An enclosed trough which conducts the water to a water-wheel.
Cleading—Covering of planking or iron plates to strengthen tunnel sides in loose ground.
Cleat—A block of wood which furnishes a steady point of attachment for a part of a structure.
Closer—A brick cut in half longitudinally.
Coffer-dam—Water-tight enclosure of piling or of cast-iron plates bolted together; used in building piers to keep water out of work.
Continuous beam —A beam which rests on more than two supports.
Coping — A covering of impervious material on the top of a wall, or the curb at the edge of a dock.
Corbel—Short piece of wood interposed horizontally between the head of a post and a supported beam.
Counterbracing — Diagonal bracing introduced into a truss or girder for the purpose of giving additional support.
Counterfort — Projection from the back of a retaining wall, added to increase stability.
Course—A continuous range of stones or bricks, of uniform height, in a wall.
Crab—Small portable crane to raise material.
Cradle—The end girders of overhead travelling cranes which carry the running wheels.
Cramp—Metal tie used for uniting the several stones of a wall.
Creeper—Iron instrument, like a grapnel, with four claws, for dragging the bottom of a harbour or river to find anything lost.
Crib—A timber construction filled with rubble stone.
Crib work—Series of layers of logs, laid alternately lengthwise and crosswise, notched and pinned to each other at their intersections.
Cross bracing—Diagonal bracing introduced into a framed structure for the purpose of preventing lateral movement.
Crowbar—An iron rod flattened and bent at one end for use as a lever.
Crutch—Piece of timber in the shape of a bent knee.
Cuddy—Three-legged stand forming a fulcrum for lever in lifting stones or heavy weights.
Culvert—A drain carried under a road or railway.
Curb—Suitably formed ring of brickwork or cast iron at the base of a shaft, surmounting a circular orifice in the roof of a tunnel.
Cushion—Stone situated upon the top of a pier upon which an arch is built.
Cut and Cover—The operation of making a cutting, building a tunnel in the opening, and then replacing the covering material.
Cutters—Bricks of special quality for cutting to shapes.
Cutwater—Lower portion of a pier separating two arches of a bridge.

DAM—An earthen or masonry wall to retain a body of water as in an impounding reservoir.
Dead Neap—A very low tide.
Derrick—A form of crane in which the radius of the jib is rendered capable of alteration by means of chains or guys passing over the top of the mast.
Digger—Apparatus used for mechanically excavating earth, etc.
Dike—Term sometimes used in the same sense as embankment.
Distress—A beam or structure is in distress when it is subjected to undue or excessive stress, or to an amount exceeding the working stress.
Dog—Iron holdfast, or piece of round iron with the ends bent at right angles and sharpened.
Dolly—Intermediate short post of timber used in pile driving.
Double butt strips—Two covering strips employed in making a butt riveted joint, one strip being placed on each side of the abutting plates.
Dowels—Pins, either of wood or metal, used by pattern-makers to retain portions of patterns temporarily in position during the process of moulding, which portions, if firmly nailed or screwed, would prevent good delivery from the sand.
Dressing — Slopes of embankments and cuttings dressed to smooth and regular surfaces.
Drift—Small horizontal or inclined underground passage.
Drove—A narrow channel or drain.
Dumby—A floating barge connected with a pier.

EBB—The condition of a tidal river when running out. A falling tide.
Enrockment—Term applied to the stone filling upon breakwaters, banks of rivers, etc.
Extrados—The outside or upper surface of an arch.

FACE—Surface exposed by excavation in tunnelling.
Fair—Parts are said to be flush or fair when their surfaces are on the same level.
Female—The recessed portion of any piece of work into which a dowel or projecting piece fits is called the female portion.
Fender piles—Timbers placed in front of quay walls.
Fish-bellied—Girders and ribs are said to be bellied, or fish-bellied, when they are curved underneath, the depth of curve increasing towards the centre.
Fish-bolt—A bolt employed for fastening fish-plates and rails together.

Fished beams—Beams joined by fish-plates.
Fish pieces—Pieces of wood or iron connecting two pieces of a tie in a fished joint.
Flanks—The sides of an arch.
Flashes—A description of sluice.
Flitch-plate—A plate of metal bolted between two timber flitches to strengthen them.
Floating clough—Movable dam or machine used for scouring out inlets.
Floating derrick—A derrick crane placed on board a floating hull for transferring goods to and from vessels, independently of proper wharf and dock accommodation.
Flow—The condition of a tidal river when running up. A rising tide.
Fluffy—Timber is said to be fluffy when the sawdust is stringy and moist, or greasy instead of granular and sharp.
Flush—Parts are said to be flush or fair when their surfaces are on the same level.
Flush bolt—A bolt whose head is let into a recessed hole so that its top face stands level with the face of the material into which it is sunk.
Foot blocks — Flat pieces of wood placed under props to give a broad base.
Formation breadth—The width of the bed of a railway below the ballast.
Formation level—The level of a road or railway prepared for the road metal or ballast.
Four-foot—The space between a line of rails over which the traffic runs.
Full—A term which signifies that the dimension is very slightly over the size preceding the term.
Full way—A water-way is said to be full when the area of the opening in the valve or plug, as the case may be, is equal in extent to the area of the pipe.

GAD—Wedge of steel for driving into crevices or openings made by pick or chisel.
Gallery—Same as *Drift*.
Galletting—Small splinters of stone inserted in the joints of coarse masonry.
Gangway—A passage way or portable footbridge.
Gantry—The trussed beams, or girders, as the case may be, which carry the crab or crane in overhead travelling cranes; also the timber substructure.
Gibbet—The triangular framework of a crane consisting of post, jib, and strut.
Gin—A rude, portable, yet effective hoisting machine of the well-known tripod form, from whose apex the pulleys and gin-blocks for lifting are suspended for working heavy tackle. A barrel and winch are fixed between the two legs which form the shears.
Gin-block—A single-sheave pulley of a hollow-rim section, having its bearings in a skeleton frame suspended from a hook. A rope is passed over the pulley, one end of which is held by a man, the load being attached to the opposite end. There is thus no gain of power, but only an alteration in the direction of motion.
Goliath — A travelling crane supported on high trestles moving upon rails.
Grab—Machine used for excavations.
Gridiron—A simple framework of timber placed to admit of vessels being floated above it at flood tide and grounded upon it during the ebb for the purpose of examination.
Grillage—Term applied to sleepers and cross beams supporting a platform.
Groyne—A timber framework constructed across a beach between high and low water mark in order to prevent portions of the beach being washed away.
Ground moulds—A portion of the framework used in tunnelling to guide the bricklayers.
Ground square—Two straight-edged strips of board, the ends of which are so united as to form a right angle.
Grout—Liquid mortar used for running into dry joints in brick or stonework.
Gullet—Small preliminary working cutting about 15 feet wide.
Gusset—An angle-iron bracket used to stiffen an angular portion of a structure.

HAUNCH—That part of an arch between the keystone and the springing.
Header—A brick placed with its greatest length at right angles to the face of a wall.
Heading—Small horizontal or inclined underground passage driven in advance of the full-sized excavation.
Hedgehog—Machine for removing mud and silt from rivers and streams.
Heel—The thick or broad end of a wedge-shaped piece of wood or iron.
Heel post—The vertical member at the shore end of a lock-gate, with a pivot at top and bottom upon which it swings.
Hoggin—Small sifted gravel.
Hollow quoins—Cylindrical recesses in which gates of locks, etc., are hinged.
Horn plate—The upright frames in which axle boxes slide.

IMPACT—The sudden fall of a load upon a beam or structure. The deflection of beams varies nearly as the velocity of impact.
Impact wheel — A water-wheel which is driven by the percussive force of water acting at right angles to the floats and at a tangent to the circumference of the wheel. Turbines are impact wheels.
Imposed load—The load which is extraneous to a structure, and distinguished from that due to the structure itself.
Impost—A sort of capping at the top of a pier supporting an arch.
Impulsive load—A load applied suddenly to a structure. The structure is thus subject to the accumulation of energy due to the impact of the load, or that gathered in its motion, in addition to its actual dead weight.
Indifferent equilibrium—The equilibrium of a body which is neither stable nor unstable. If, when a body is moved longitudinally, the centre of gravity moves in a horizontal line, as in a sphere, the equilibrium is said to be indifferent.
Internal Stress—Stresses set up in the internal portions of castings and due to unequal contraction caused by differences in their mass.
Intrados—The under side of an arch.
Island platform—A railway platform with a track upon each side of it.

JIB—The strut or thrust member of the framing of a crane. It is always in compression.
Jib-legs—Timber legs pivoted to the jib pin of a crane. Reaching to the ground, they afford a firm and broad base to the jib when lifting, and so prevent the crane from overturning. When not in use they are shipped over the side frames.
Jim-crow—A portable rail straightener or rail bender.
Jogle—Keys of hard wood, or other material, used to resist shearing stress at the junction of two beams by being let into the surfaces, the beams being fastened together by vertical bolts in the spaces between the keys.
Journal—The portion of a rotating shaft which is in contact with its bearing.
Jumper—Long iron instrument with sharp steel point for making holes in rock or hard ground.

KENTLEDGE — The loose balance weights supplied with a balanced crane.
Key—The wedge used to fasten the rail in the chair on railways.
Keystone—Highest stone in the centre of an arch.
King post—The central upright in a roof truss against which the rafters abut, and which supports the tie beam.
King truss—A truss formed with a king post.
Knuckle joint—A joint in which an eye at the end of a rod is embraced by the forked end of a second rod, the two being connected with a joint pin.

LAP JOINT—A joint produced by the overlapping of contiguous faces of metal.
Lattice—Diagonal bracing forming struts and ties.
Lattice web—A girder web made by lattice bars, as opposed to a plated web.
Leading-frames—Framework formed to guide bricklayers in making brickwork tunnels.
Leat—Artificial channel for conducting water to water-wheels.
Lengths—Successive sections in which a tunnel is executed.
Lewis—Truncated iron wedge or dovetail, used with larger end downwards, for lifting stones by chains.
Life—Expressive of the total period during which a structure remains efficient.
Life-wall—Cross-wall of a back chamber in a tunnel.
Lining—Term applied to puddle clay reduced to a semi-fluid state, and laid along the bottom and sloping sides of canals, etc.
Lockage—Expenditure of water in passing boats from one level to another.

MALE—When a stud or a dowel fits into a recess it is said to be the male portion of that particular piece of work.
Meeting post, or mitre post—The vertical member of a lock-gate where it meets the other gate.
Metalling — Term applied to the covering of roads generally.
Mitre joint—A butt joint whose ends are cut at an angle of 45 degrees, the abutting sides therefore forming an angle of 90 degrees.
Monkey—The clip hook which lifts and releases the ram in pile driving.
Monkey-engine—Apparatus used in driving piles.
Monkey wheel—See *Gin-block*.
Mushroom—Horizontal single sheaves which act as leads for a rope to a capstan.

NEEDLE—Set of square bars of wood used for opening flood-gates in a weir.

OFF LETS—Pipes placed at the level of the bottom of a canal and fitted with sluices.
Ordnance datum—The base from which ordnance levels are measured. A mark cut on the wall at the entrance to the Mersey Docks, Liverpool. Mean half tide sea level.
Overshot wheel—A water-wheel which is turned by the gravity or weight of the water emptying itself into buckets at the top of the periphery.

PENSTOCK—A sluice or flood-gate.

Permanent load—A load which is constant and unvarying and a dead load, as the weight of a structure itself, or a load imposed thereon, or both taken in conjunction as distinguished from a live or a rolling load.

Permanent way—The road bed and rails upon which trains are run.

Pile hoop—An iron band, shrunk on the head of a pile to prevent splitting of the timber while being driven in.

Pinch bar—A bar of iron, or wood shod with iron, used to move heavy loads for short distances by " pinching " them along.

Pitch—Inclination which the sides of a roof make with the horizontal.

Polings—Planks or deal ends, by which the sides of an excavation are supported.

Proof load—A load imposed on a structure greater in amount than the working load, in order to test its capability or margin of safety. The deflection of a structure, when under its test load, is carefully noted and its capability deduced therefrom.

Props—Struts or posts, either vertical or raking, used as supports in tunnelling.

Puddle—A mass of tempered clay, to prevent the passage of water.

Punch—Same as *Dolly*.

Purlins—The members which unite the trusses of roofs in longitudinal directions.

Putlogs—Short poles used for scaffolds.

QUEEN POST—A roof member which fulfils a similar function to that of the king post, its position only being different.

RABBET, or REBATE—A shoulder or recess on the edge of a piece of wood or metal for the reception of the edge of another similar piece.

Race—Cut along which water is conveyed to and from a water-wheel.

Rail gauge—The width in the clear between the two adjacent sides of the top flanges of the rail upon railways.

Rakers—Same as *Props*.

Ram—Heavy weight dropped on to piles when they are being driven.

Ranging—Laying out the line of a tunnel.

Retaining wall—A wall to hold up a bank of earth, usually battering on the face.

SCARFING—Method of connecting ties or beams, the ends of the two pieces overlapping.

Scouring power—Stream of water employed in connection with harbours to carry away the shingle, etc., to prevent its accumulation at the mouth.

Scuttling—Method of stirring up deposits by mechanical means.

Semi-beam—A beam fixed at one end and loaded at the other or loaded uniformly.

Shearing stress—The stress to which a body is subject when force is applied to it in a direction parallel with its section. Its mean intensity is equal to the shearing force divided by the area of the section.

Shear legs—A rude but strong form of crane, having three legs or pillars of timber or iron, set leaning at an angle towards each other for supporting the lifting tackle. The gear wheels may be attached to one of the legs, or be fixed independently, and hand or steam power may be employed.

Sheet-piling—Row of timbers or piles driven firmly, side by side, into the earth.

Shoe—A cap, or socket, which receives the end of a piece of timber and which sustains the end pull of a truss rod, or takes the thrust of the legs of shears, or carries a pivot or bearing as in pillars of wooden cranes, or acts in a general way as a protection to timber ends, as in pile shoes.

Shore—Pieces of timber placed diagonally against walls, to support them.

Shoulder—That portion of a shaft or a flanged structure where an immediate increase of diameter occurs.

Sills—Strong timbers of large dimensions, placed horizontally across the line of a tunnel to support the props, etc.

Side width—The distance required from the centre line to form a road or railway.

Silt—The alluvial soil washed down and deposited on the bottom and sides of rivers by the action of the tides.

Six-foot—The space between two railway tracks.

Skew-back—Large stones cut to an angle to receive the end of an arch.

Skew-bridge—A bridge formed with an oblique arch, usually constructed with spiral courses.

Skin-dam—A dam consisting of a single row of sheeting piles of whole or half timber, with tiers of horizontal wallings or planks.

Slurry—Liquid mud or cement mortar.

Soffit—The under side of an arch.

Sough—A small drain, situated at the top of an embankment.

Span—The clear width between the supports of a girder or arch.

Spandril—The portion on the top of a pier between one arch and another.

Spider wheel—A wheel or pulley having light arms of wrought iron or steel.

Spoil, or spoil bank—The surplus material excavated, which is laid by the side of a railway or canal.

Spoon and bar—Tool used in hand-dredging.

Springing-line—The line in which the soffit of an arch intersects the pier.

Staiths—Short tongues or jetties used for coaling.

Starling—The angular form of a pier-head in bridge work.

Stirrup—A strap which supports a beam or sustains the thrust from one end of a strut.

Strain—The change of form produced in a body by a stress.

Stop-planks—A description of dam employed on canals.

Stress—When materials and structures are subjected to straining forces those forces are resisted by internal molecular actions called stresses, transverse, shearing, or torsional.

Stretcher—A brick with its greatest length placed parallel with the face of a wall.

Striking-plate—The apparatus by which the centre is lowered after the arch of a bridge has been completed.

Struts—These may be vertical or diagonal and connect a beam with a truss rod. Through them the strains due to deflection of the beam are translated into those of tension in the rod. In roof trusses those members which extend diagonally from the beam or from the foot of the king post or queen post either to the rafters or to the shoulders of the queen posts.

Surcharged wall—A retaining wall to hold back a bank of earth sloping upwards above the top of the wall.

Sump—Hole at the bottom of excavations into which water is drained, and in which the end of the suction pump is placed.

TAIL—The hinder part of a portable crane upon which the balance box rests.

Tee-irons—Rolled wrought iron bars whose section is that of a letter T. They are employed in engineering constructions such as bridges, girders, and roof work.

Teeming—Depositing earth in an embankment.

Temoin—Earth pillar left in excavations.

Tenon—A tongue projecting from the end of a piece of timber, and which, with the mortice into which it fits, is one of the common joints in woodwork.

Terring—Scotch term for soil removed in clearing the top of a quarry.

Thimble—Ring attached to a buoy.

Thirl or thirling—Meeting of workings approaching each other from opposite directions in tunnelling.

Thorough—A term applied to the heading stones forming a wall.

Thrust—The compressive force exercised by a body transmitting pressure.

Tine—An iron or steel claw used in dredging operations.

Toggle—A bar of iron or wood used to tighten a chain or rope by twisting two lines together.

Tongue—This is a short piece of metal or wood projecting from one portion of a structure and entering into another, in order to ensure steadiness and to prevent overlapping of joints.

Transom—Horizontal framing in bridge work.

Traveller—A framework carrying a lifting crab and able to travel along elevated rails.

Trenail—Wooden pins of large diameter used as fastenings for joints.

Trig station—A place where a theodolite is set up for the purpose of taking an observation.

Truss—Triangular frame in bridge and roof work.

Tunnel—A passage lined with brickwork or masonry, excavated through a hill or below the surface of the ground.

ULTIMATE STRENGTH—The load which produces actual fracture in a structure.

Underpinning—Additions and repairs to foundations and walls in which the latter are first supported by strong timber shores and needles.

VOUSSOIRS—Wedge-shaped blocks in bridge-building.

WALES—Horizontal braces.

Waling—A horizontal piece of timber used to hold vertical pieces in place either in an excavation or against a jetty.

Warren girder—A lattice girder in which the struts and ties form triangles or triangular bays, the struts leaning inwards or towards the centre of the girder, and the ties leaning outwards. A Warren girder consists of a single system of triangles, while lattice girders contain two or more systems of triangulation.

Web—The plated or central portion of a structure as distinguished from its flanges and bosses. Thus, a crank web is the plate which carries the shaft and pin bosses; a girder web is the main vertical plate which becomes the connection between the top and bottom flanges.

Weep-hole—A hole for drainage made through a retaining wall or bridge abutment.

Weir—A wall to hold back a certain head of water and allow the remainder to pass over the top.

Wrinkling—The failure of thin unstayed or improperly stayed plates, by wrinkling up or becoming corrugated under pressure.

Continued from page 1834

STABILITY OF STRUCTURES

General Conditions. Beams. Bending Moments. Moment of Inertia. Rolled Joists and Girders. Shearing Stresses

By Professor HENRY ADAMS

THE varieties, characteristics, and strength of the various materials used in forming structures having been dealt with seriatim and the elements of structural mechanics explained, the stability of the structures themselves will now be considered. The subject may be approached from several distinct points of view, but the study will perhaps be facilitated by commencing with a simple beam of timber supported over an opening and carrying a load on its upper surface, as in **116**.

Strength of Beams. The width of opening beneath the beam is called the span, or the clear span, and for ordinary purposes may be assumed to be the effective span; but the latter is more correctly taken as the distance from centre to centre of the bearing surfaces. The use by architects of the term *bearing* instead of span should be discountenanced, as the bearing is the portion in contact with the support at each end. In making investigations of stability it is convenient to eliminate all unnecessary details and to show the forces in action by lines, so that the beam may be drawn as **117**.

Concentrated Loads. The first effect of the load is to put pressure on the supports. When the load is in the centre it is self-evident that the pressure on each support, and the consequent reaction of each support, will be equal to half the load; but when the load is placed out of the centre as in **118**, it will be necessary to take it as a question of leverage. The reaction at A will be $W \times y \div L$, and the reaction at B will be $W \times x \div L$. Let $W = 5{,}000$ lb., $L = 10$ ft., $x = 6$ ft., $y = 4$ ft., then the reaction at A

$$= \frac{5000 \times 4}{10} = 2000 \text{ lb.},$$

and at B

$$= \frac{5000 \times 6}{10} = 3000 \text{ lb.},$$

and as the maintenance of equilibrium depends upon the vertical load being resisted by equal and opposite reactions the result is proved correct by the equation $2000 + 3000 = 5000$.

Bending Moments. The next effect to consider is the bending of the beam—not so much the actual bending, but what is called the bending moment (M), which is the measure of the effect of the load in producing stresses in the beam. This, again, is a question of leverage; it is the reaction at one end multiplied by the distance to the load, reaction at A multiplied by x, or reaction at B multiplied by y. Thus, 2000 lb. $\times$ 6 ft. = 12000 lb.-ft., or, working from the other end, 3000 lb. $\times$ 4 ft. = 12000 lb.-ft., or $12000 \times 12 = 144000$ lb.-in., the accuracy being proved by the agreement of the results obtained from opposite ends.

Moment of Resistance. Opposed to the bending moment is the moment of resistance (R), or, in plain language, the strength of the beam. This is made up of the natural strength of the material, the area of the cross-section and the disposition of that area in the directions of breadth and depth. The natural strength of the material is given in the tables of strength, page 1396, as modulus of rupture (C).

Modulus of Rupture. The *modulus of rupture* is the virtual stress in pounds per square inch which the extreme fibres will bear under a transverse load. It is eighteen times the load in pounds which placed in the centre will just break a beam 1 in. square when resting on supports 1 ft. apart. If we assume the beam to be Memel fir, the modulus will be 8,000. This breaking load upon the unit beam may be distinguished as *the coefficient of transverse strength.*

Modulus of Section. The remaining elements of strength—*viz.*, the area and its disposition—are called the modulus of section (Z), so that we have the equation $M = Z \times C$. For a rectangular beam of breadth b and depth d, the modulus of section (Z) is $\frac{bd^2}{6}$, and it will be shown presently how this is arrived at. If the load be insufficient to break the beam, the value of resistance (ZC) will exceed that of bending moment (M), and the former divided by the latter will give the factor of safety, or the number of times the actual strength of the beam exceeds the strain put upon it by the load.

Assume the beam to be 6 in. wide and 12 in. deep, then

$$Z = \frac{bd^2}{6} = \frac{6 \times 12^2}{6} = 144,$$

and as $C = 8000$ and $M = 144000$,

$$\frac{ZC}{M} = \frac{144 \times 8000}{144000} = 8,$$

factor of safety. It will now be desirable to see how the modulus of section is made up. The beam in bending will have the lower portion extended and the upper portion compressed, the stresses diminishing gradually towards the centre of the depth where they disappear, and the change takes place from one kind to the other. This line of no stress is called the *neutral axis* when considering the cross-section

and the *neutral layer* when considering the whole beam.

If diagonal lines be drawn upon the section of the beam, as in **119**, the horizontal line through their intersection will be the neutral axis. Bearing in mind that the extreme fibres at the top and bottom are those subject to the greatest strain and that the strain reduces towards the neutral axis, it is possible to conceive that the same total strength would result if the resistance spread over the width of each successive layer could be gathered into a narrower space, so that all the fibres within the narrowed space would be under uniform stress.

Inertia Area. This would give the effective area indicated by the shaded portion, and the fibres within it are assumed to be all equally strained. It forms what is called the *inertia area* of the beam section, and the resistances of the fibres to compression or extension may be considered as a series of parallel forces acting at their centres of gravity, shown by the dot in a circle. On the principle of couples explained in the last chapter, the area (A) of one shaded triangle represents a series of parallel forces which may be replaced by their sum, whose centre of effort is at the distance g from the neutral axis, or the *arm of the couple* will be $2g$. Then the moment of the couple, or the *modulus of section*, will be $A \times 2g$. But A by inspection

$$= \frac{bd}{4} \text{ and } 2g = \tfrac{2}{3}d,$$

therefore,

$$A \times 2g = \frac{bd}{4} \times \tfrac{2}{3}d,$$

whence, the modulus of section Z

$$= A \times 2g = \frac{bd^2}{6}.$$

Moment of Inertia. The moment of inertia (I) is very closely allied to the modulus of section (Z); it will be obtained by multiplying Z by the distance from the neutral axis to the furthest edge of section, y, so that $Zy = I$, or, as it is more generally stated, $\frac{I}{y} = Z$. The moment of inertia (I) is really the basis of the modulus of section (Z). It is made up by the summation of the quantities obtained by multiplying the area of each individual fibre by the square of its distance from the neutral axis, and although the moment of inertia enters into many formulæ, we may for the present postpone its further consideration.

Graphic Representation. With a central load, as **117**, the maximum bending moment is half the load multiplied by half the span, or $\frac{WL}{4}$, which, in this case,

$$= \frac{5000 \times 10}{4} = 12{,}500 \text{ lb.-ft.};$$

and if a triangle be drawn to scale below the beam, as in **120**, the vertical distance between the beam and the outline of the triangle will give the value of the bending moment at any point of the beam. It will thus be seen that it varies from a maximum in the centre to nil at the ends. When the load is shifted out of the centre, as in **118**, the maximum bending moment

$$= W\left(\frac{x \times y}{x + y}\right),$$

occurring directly under the load, so that the triangle of bending moments will now become as **121**.

Distributed Load. A uniformly distributed load acts as an infinite series of concentrated loads giving a maximum bending moment in the centre of $\frac{WL}{8}$, or half that due to a concentrated central load, but the diagram will now be a parabola, as **122**.

Two or More Concentrated Loads. When two loads W and W′ act upon a beam, as **123**, the maximum bending moment for each must be found separately, as shown, and the overlapping parts must be added outside to make the complete diagram, as **124**.

Partial Distributed Load. When a distributed load occupies only part of the span, as z in **125**, the triangle must be found as for a concentrated load at the centre of gravity of the distributed load $= \frac{WL}{4}$, and then, dropping vertical lines from each end of the load to meet the triangle, a parabola must be set out from the line joining the points so found $= \frac{Wz}{8}$. Bending moment diagrams may be drawn in a similar way for any other combination of loading, and in any beam or girder it is always the greatest depth of the shaded figure that gives the maximum bending moment, which the moment of resistance has to balance. A very simple formula for the practical use of fir beams is $W = \frac{bd^2}{L}$, where W = safe load in cwts. distributed, b = breadth of beam in inches, d = depth in inches, and L = clear span in feet. This allows a factor of safety of 7, which is a suitable one for ordinary work. Also, if w be the load in cwts. per foot super. to be allowed on a floor, and c the distance in feet between the centres of joists, bd^2 must equal cwL^2.

Use of Tables. The modulus of rupture for transverse strength is C in the formula $M = ZC$, and is given in the table on page 1396. The coefficient of transverse strength is another figure used as a substitute for the above in ascertaining the strength of beams; it is c in the formula $W = \frac{cbd^2}{L}$. It is usually given in cwts., when L is in feet, as quoted by Hurst and others. In general, $C = 18c$.

Rolled Joists. Rolled iron joists of the present pattern were first made in 1849 in

Belgium, and about 1851 in England. Similar sections in mild steel came into use about 1880, and the rolled iron joists went out of use about 1896. In 1902, the Differdange wide flange beams were introduced, and in 1903 the British Standard Sections were formulated. Within the limits of their capacity, rolled steel joists form the most perfect girder obtainable, and the disposition of the metal in the flanges and web conduces to the greatest economy of material, as well as of weight and cost.

Advantage of Flanged Beams. A flanged beam carrying a load has the same general distribution of stress as a rectangular beam, but the material is more efficiently placed. In the rectangular beam the material is uniformly disposed throughout the depth, but the stress being reduced towards the neutral axis, only the extreme fibres can be strained up to their capacity. In the flanged sections, as much of the material as possible is put at the upper and lower extremities, so that what there is of it is under nearly the maximum stress, the web being used to keep the flanges apart. Or, putting it another way, the central portion of the depth of the rectangular beam has so little leverage to resist the bending moment that it is comparatively useless, while in the flanged beam the greater part of the material has the maximum advantage in the way of leverage. The bending moments are independent of the shape of the cross-section of a beam, but, as already stated, the moment of resistance depends upon the shape and disposition of the material in the cross-section.

Principle of Flanged Beams. The strength of a flanged beam may be shown approximately in a very simple manner by a pair of "couples." The elevation of a flanged beam supported at the ends and loaded in the centre is shown in **126**. Taking the right-hand side, the couple formed by the half-load and reaction on that side, with the leverage arm of half the span, produce a bending moment of $\frac{1}{4}Wl$, with positive or anti-clockwise rotation. This is resisted by the couple formed of the tensile strength multiplied by the area of bottom flange, and the compressive strength multiplied by the area of the top flange, the lever arm being the mean depth centre to centre of flanges, producing a resisting moment of cAd or tAd. Mild steel has practically the same resistance to compression as to tension, and 8 tons per square inch may be taken as the maximum working allowance. Taking a 12 in. by 6 in. by 54 lb. per foot rolled steel joist, the sectional area of each flange is 5·22 sq. in., then the safe central load on a span of 20 ft. will be given by the equation

$$\frac{Wl}{4} = tAd,$$

or

$$W = \frac{4tAd}{l} = \frac{4 \times 8 \times 5{\cdot}22 \times 11{\cdot}63}{20 \times 12}$$

= say, 7·65 tons. A beam of uniform section will carry twice the load distributed that it will carry with the same effort in the centre, so that this joist will carry $7{\cdot}65 \times 2 = 15{\cdot}3$ tons distributed. The published tables issued by manufacturers give the strength as 16 tons, the slight difference being due to the assistance given by the web, which has not here been taken into account.

Strength by Moment of Inertia. The true strength of a rolled joist will be obtained by using the moment of inertia, in the formula

$$\frac{Wl}{8} = \frac{I}{y}C.$$

The actual section of a rolled joist is as shown in **127**, but for purposes of calculation it may be simplified to **128**. Then the moment of inertia will be

$$I = \frac{bd^3 - h^3(b-t)}{12};$$

also, it will be seen that $y = \frac{d}{2}$, and as the modulus of section $Z = \frac{I}{y}$, it will be given direct by the formula

$$Z = \frac{bd^3 - h^3(b-t)}{6d}.$$

Taking the 12 in. by 6 in. by 54 lb. rolled joist

$$I = \frac{6 \times 12^3 - 10{\cdot}25^3(6 - {\cdot}5)}{12} = 376{\cdot}5,$$

and the other conditions being as before,

$$W = \frac{8CI}{ly} = \frac{8 \times 8 \times 376{\cdot}5}{20 \times 12 \times 6} = 16{\cdot}73 \text{ tons}$$

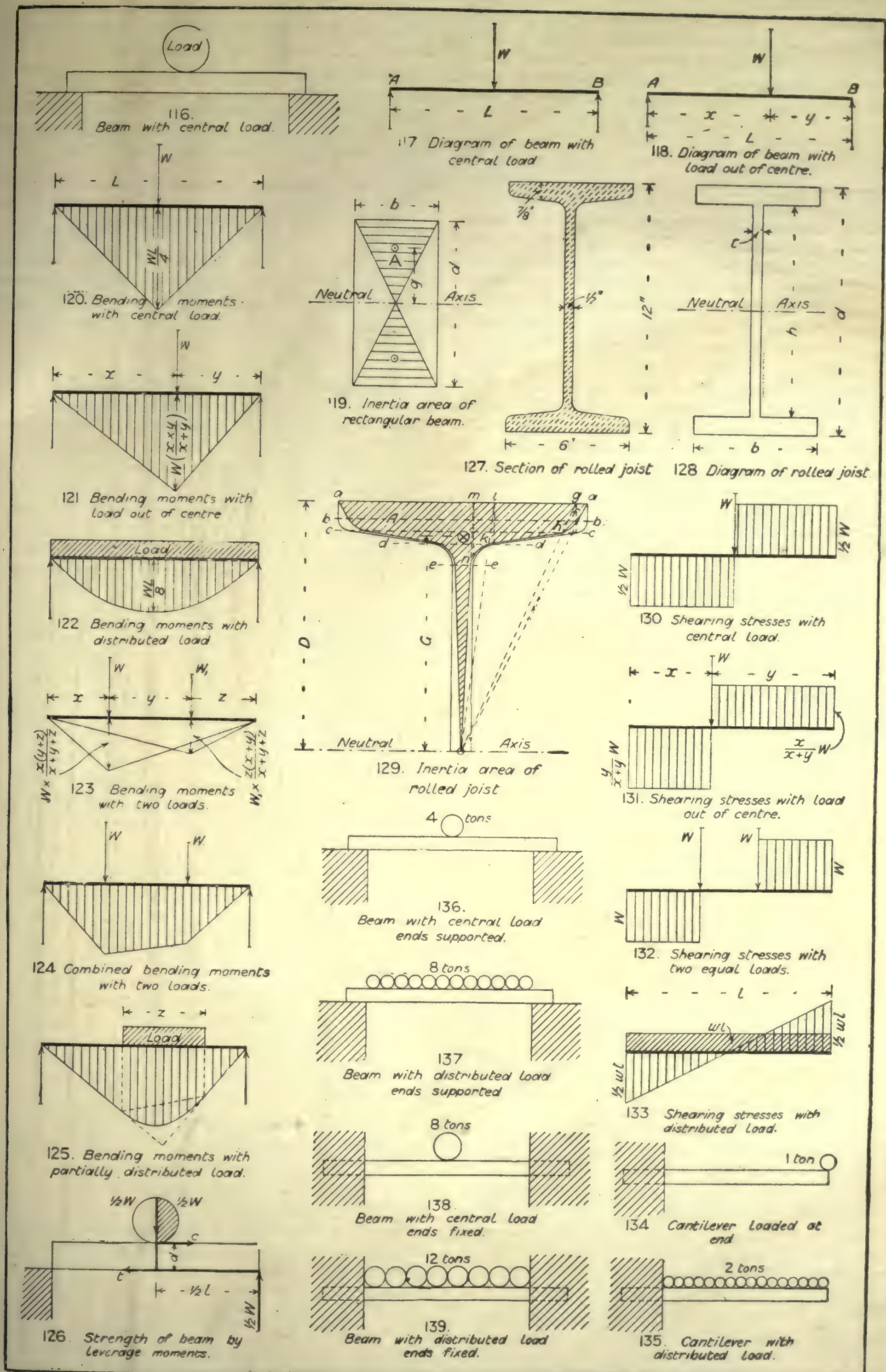
distributed, as against 15 found by simple leverage.

The published tables of rolled joists, such as those by Dorman, Long & Co., give the exact moment of inertia, in this case 369·91, and what they generally call the moment of resistance in square inches, which is really the modulus of section (Z) in inch units. They also give a value for the distributed load in tons that 1 ft. will carry under different factors of safety. The tabular value divided by the span in feet gives the safe load in tons, and it is useful to know that with any kind of loading when the maximum bending moment in ton-feet is ascertained, eight times the amount gives the tabular equivalent. For example, in the above beam the bending moment

$$\frac{Wl}{8} = \text{say, } \frac{16 \times 20}{8} = 40 \text{ ton-feet,}$$

and $40 \times 8 = 320$, while the table gives 328·8; and the span being 20 ft. the tabular value $328{\cdot}8 \div 20 = 16{\cdot}44$ tons safe load distributed.

Finding Moment of Inertia Graphically. The principle applied to finding the inertia area of the rectangular beam can be applied to the rolled joist. Draw the upper half of joist, above the neutral axis NA [**129**], to a large scale—full size or half full size is best. Draw horizontal lines *a-a*, *b-b*, etc., across the section wherever the direction of the outline changes. Join *a* with the centre O cutting



STRENGTH OF BEAMS UNDER VARIOUS CONDITIONS OF LOADING

line b-b in f. From c draw a vertical line to meet a-a in point g, and join gO, cutting c-c in h. Draw a vertical line from d to meet a-a in i, and join iO, cutting d-d in k. From e draw a vertical line to meet a-a in m, and join mO, cutting e-e in n. Then $afhkn$O will be one half of the outline of the inertia area. Do the same on the other side of the centre line, when the complete inertia area for one-half the depth will be as shown by the shaded portion. Cut this figure out and suspend it from two points to obtain the position of its centre of gravity, marked × at a distance G from neutral axis. Trace the outline of the figure by a planimeter and find its area A, of course, allowing for the scale to which the figure is drawn. Then 2DAG will be the moment of inertia of the whole section.

By experiment it is found that for the 12 in. by 6 in. by 54 lb. rolled steel joist D = 6 in., A = 6 sq. in., G = 5·15 in., then 2DAG = 2 × 6 × 6 × 5·15 = 370·8. The moment of inertia of any irregular figure can be found in a similar manner, but the neutral axis must pass through the centre of gravity of the whole section, and the inertia area found for each side separately, adding the two areas together for the final result and omitting the prefix 2.

Shearing Stresses. Before leaving the rolled joist reference may be made to shearing stresses. When a central load is carried by a beam, the shearing stress is of uniform value throughout the length, and is equal to half the load, or one of the reactions—that is to say, starting from one abutment and calling the shear positive, it retains its value unaltered until it meets the load, the load being deducted then gives a negative shear stress of the same value, $\frac{1}{2}$W, as in **130**. When the load is out of the centre, the same method must be followed as in **131**. With two equal loads symmetrically placed between the abutments, as in **132**, it will be seen that the shearing stress vanishes between the loads.

With a uniformly distributed load, adopting the same general principle, the graphic diagram will appear as **132**. The flanges of a rolled joist are assumed to take the whole of the bending moment, and the web the whole of the shear stress. Generally, there is ample strength in the web, so that it is usual to omit calculation for shear, but there are cases, such as short, deep joists with heavy loads, where calculation is desirable.

The effective depth of web may be taken as five-sixths of the total depth of joist less mean thickness of two flanges—*e.g.*, in the 12 in. by 6 in. by 54 lb. joist, the mean thickness of flanges being ·87 in. each, the effective depth of web will be $\frac{5}{6}$(12 − 2 × ·87) = 8·55 in. The thickness is ·5, making the sectional area 8·55 × ·5 = 4·275 sq. in. The maximum shear with a distributed load of 16 tons = 8 tons, and the working allowance for shear stress being 6 tons per square inch, the safe capacity of the section to resist shear will be 6 × 4·275 = 25·65 tons, against the actual maximum of 8 tons. Had the joist been only 6 ft. span, the safe load, regarding only the flange stresses, would have been $\frac{328 \cdot 8}{6} = 54 \cdot 8$ tons, giving a maximum shear of $\frac{54 \cdot 8}{2} = 27 \cdot 4$ tons, against a safe capacity of 25·65 tons, or just beyond the limit of safe strength. In such a case it would be necessary to fit a vertical angle, or tee, or even flat plate, between the flanges, and bolt or rivet it to the web just over the edge of the bearing surfaces.

Relative Carrying Capacity. The relative carrying capacity of cantilevers, beams, and girders, according to the method of loading and supporting, is shown very clearly by the illustrations **134** to **139**. The first two and last two are not well suited for timber, as it has to be built in the wall so deeply that it tends to decay from want of ventilation. The last two beams are in very much the same condition as a girder continued over several spans, the ends, at the limit of each span, being "fixed" by continuity with the next span.

Strength of Structures. The strength of structures varies as the square of the linear dimensions of similar parts, excluding the effect of weight, but the weight varies as the cube of the linear dimensions. The strength of a structure of any kind is not, therefore, to be determined by that of its model, which will always be much stronger in proportion to its size. All works, natural and artificial, have limits of magnitude which, while their materials remain the same, they cannot surpass (Lardner).

Safe Load on Structures. Common ratios for safe working load to breaking load are as follows:

Cast-iron columns Cast-iron girders for tanks Wrought-iron structures Mild steel structures ..	= $\frac{1}{4}$
Cast iron for bridges and floors ..	= $\frac{1}{6}$
Stone and bricks	= $\frac{1}{8}$
Timber under live loads	= $\frac{1}{10}$
Timber under dead loads and temporary structures	= $\frac{1}{5}$

The safe loads allowed on floors are:

Dwelling-houses	$1\frac{1}{4}$ cwt. per sq. ft.
Churches and public buildings	$1\frac{1}{2}$ „ „
Warehouses	$2\frac{1}{2}$ „ „

including the floor itself when of timber, but excluding it when of concrete-steel.

Continued

Continued from page 1898

COAL-DEALERS

Although not "shopkeeping" in the commonly accepted sense of the term, coal-dealing depends largely, especially in suburban neighbourhoods, on the way in which the wares are displayed. Indeed many coal offices have samples of coal neatly ticketed in their windows, and samples of stock are to be examined inside. But the relations of the coal-dealer and his clients are at first usually the reverse of those of the ordinary shopkeeper and his customer, inasmuch as the dealer goes to the customer direct to solicit his order instead of the customer coming to the shop. The coal-dealer proclaims his goods in the public street, either personally or by deputy, and the particular branch of this large and important business that we are now to consider is the small merchant—the beginner.

The Working Coal-dealer. First of all there is the man who, either by serving as carman or wharfman to a large coal merchant, has acquired a certain knowledge of the trade. He has ambitions beyond a weekly wage and a small commission, and he decides to start for himself. He has enough capital—say, £30 or £40—to buy an indifferent horse and a second-hand van, and he starts on an adventurous career with two tons of coal for which he has paid money down. This man will, of course, drive his own horse and find his own customers by the usual method of shouting his wares aloud. He will require a strong lad to help him to load and unload, and an industrious, sober man may get together a decent business. Many of the large coal businesses of to-day have been started with £40 to £60 capital, but the day of the small trader, especially in the metropolis and in large centres, is not of the present.

The Minor Capitalist. For our present purpose, perhaps it will be more useful to imagine a young man who has acquired a good all-round knowledge of the outs and ins of the coal trade, with a desire to become a coal merchant. He has been boy and wharf clerk successively to one or several big firms of coal-dealers, has kept his eyes and ears open, and has a capital of from £200 to £500. He selects a promising suburb, preferably where he is well known and where his family resides. If it be a London suburb, or the suburb of some large manufacturing centre, he will find some difficulty at the outset in getting the grant of a wharf, as it is called—a piece of ground by a railway siding—on which to store his stock of coal. In London particularly there is such competition for wharves that the railway companies have generally far more names on their list than they can supply. This makes them captious, and a new man with small capital, unless he has exceptional credentials, is passed over for the huge concerns that are ever eager for new wharves, and who may be depended upon to bring business to the yard and to pay promptly. In country districts, and especially at new stations, the reverse of this is the case. The companies are often glad to get men to use their sidings, and this is the young dealer's opportunity. The rents charged for wharves, even in London, are merely nominal; a sum of £20 to £30 a year will usually secure a wharf and an office—a box on wheels, which generally serves as the shop or office. The office should be fronting the main road to the railway-station, and should communicate at the back with the railway yard. It should be remembered that the railway companies usually lease these wharves (supposing our young friend is fortunate enough to get one), subject to termination at very short notice.

Working Necessities. The first and most expensive part of the coal-dealer's equipment is his horse. A good, sound, heavy horse should be purchased, and £40 would be a fair price to pay. The coal van, including weights and scales (which are a compulsory part of each coal van from which coals are sold retail) would cost another £30 or £40. At the wharf there must be a wooden shanty—the "men's lobby," it is called, for sheltering the workmen and for storing their tools. If there be no "lobby" already erected, a few shillings will build a new one.

A handy kind of weighing machine, known as a "Redeo," is necessary at the wharf for weighing the coals into the sacks after screening, and prior to loading the van. This costs about £4 10s., and needs "a gang" or three men to work it. Another machine called the "combined weighing machine" is largely used in the country, as one man can load and weigh with it. The sacks are simply hung on hooks, and thus a man to hold open the sacks is done away with. The sacks for this machine must be specially fitted with eyelet holes. For small businesses this machine is found very useful, and the cost is about £5 15s. Loading steps, or dolls, cost £2 10s. each; a sack barrow (used by the carman to pull back the front sacks on the van) may be bought for 10s. 6d., while a landing barrow for wharf use costs £1 10s. Other yard necessities are a 5s. tomahawk (for breaking abnormal lumps of coal, and for opening truck doors, etc.), a screen and three shovels (one for the carman and two for the yard). Bags and sacks are important items. The beginner will want at least 24 sacks, 20 1-cwt. bags, and 40 ½-cwt. bags, sufficient for a load of coal, which is usually reckoned

at two tons. These sacks and bags will cost new probably about £9 10s. to £10, but they may be hired at about 35s. per month, which includes repairs. In some districts it may probably be found necessary to do a considerable amount of trolley-work if a small general shop is also kept. That is to say, a man is sent out with small orders on a hand-trolley. There may be orders for cwts. and ½ cwts., or even smaller, quantities in the poorer neighbourhoods, and it all brings grist to the mill. Some hucksters in lower working-class neighbourhoods keep coals as one of their staples, selling out to their customers in pennyworths, and those shopkeepers are likely customers to the coal merchant for ½-ton or 1-ton quantities.

Stabling for one horse may cost anything from 1s. 6d. to 3s. per week, according to locality and accommodation provided, and horse-keep in the neighbourhood of London amounts to from 14s. 6d. to 15s. per week. A new man feeling his way will work at first with a carman and a loader only. He would probably pay the carman from 21s. to 25s. per week (with perhaps 1s. commission on every ton he sells), and the loader would receive a weekly wage of 21s. or 22s. The usual practice, however, when a business is well under way, is to pay Union rates of wages to the men. Besides the workmen, either a boy (5s. or 7s. per week) or a junior clerk (12s. 6d. a week) is necessary for the office.

Yard Work. Should the young dealer be able to get into direct touch with the collieries, which is seldom, he will probably want to have a railway truck of his own. The average price of these trucks is about £70, but they may be acquired on the hire-purchase system, with payments extending over seven years. The cautious way, however, is to hire the trucks from the collieries or railway companies. Trucks may be hired at about £8 a year, including repairs. This includes painting. The disadvantage of having no wharf is shown in the fact that the railway companies insist on the trucks being cleared in six clear days—counting the day of arrival and despatch day—otherwise demurrage is charged. All the coal is "screened" before delivery to customers. This is done by the men in the yard, the small coal passing through the screen being sold separately for ballast burning or for the furnaces at large factories. After screening, each sack is weighed before being put on the van, and skilled coal-heavers are very expert, unloading a truck into vans in a surprisingly short time.

The Middleman. In the metropolis and in big provincial centres, the beginner will probably find it most advantageous to make an arrangement with some large firm of coal merchants of known repute for a steady supply. In this way he will avoid all snubbing by the lordly colliery owners, who prefer to deal with the big men, and may neglect the orders of the small buyer. By this means also the absolute necessity for a wharf may be avoided, or postponed. As a matter of fact, unless a man has a wharf of his own he *must* buy from the merchants, and, as we have already indicated, the big coal companies block the small man at every possible corner, possessing as they do all the advantages that large capital has over small. On the whole, in London at least, the small man will find many advantages in the middleman, particularly when it is remembered that the coal companies only charge the smaller dealer a matter of 1d. to 3d. per ton more than the colliery price, plus, of course, the carriage to station.

Interesting the Public. The usual method of advertising, and one which is said to bring the best results, is by house-to-house distribution of coloured cards. These are familiar to most householders, and something in that line different from other dealers is advisable. An advertisement in the local newspaper is always politic, and the name and wares of the coal-dealer should always appear on the local time-tables issued by suburban printers. Local literature, such as bandstand programmes, chair tickets (if there is a park with a bandstand in the neighbourhood), concert programmes, and such like are all amenable to the insidious instillation into the public mind that "So-and-So's nuts" are the finest and most desirable obtainable, and his prices are the lowest. A sum of £5 spent in judicious advertising of this sort gives a fillip to a new business. Moreover, the advantage of the shop window display is now becoming more and more recognised among coal owners. A matter of £15 or £20 spent in erecting an attractive office, with glass facias, gold-block lettering, and a profusion of electric lights is in itself an advertisement which compels attention.

Buying. The best time to buy largely is in June, July, and August. Then coals are at lowest summer prices, as there is less demand than at almost any period of the year. The man with a wharf or yard, therefore, should endeavour to lay in his winter stock at that time, so that he will have something to fall back on when winter prices are ruling. The prices are usually regulated by the leading merchants, or colliery agents, on the coal exchanges all over the country. The dealer has first to aim at discovering what kind of coal is likely to sell most quickly in his neighbourhood. He should not be too greedy for profits at first; the primary obligation is to please his customers, so that he may get repeat orders and, therefore, a *clientele*. And providing he has bought cheaply, judiciously, and with foresight in the summer, he may expect to reap his harvest, if prices are closely watched, between January and March.

Varieties of Coal. There are only six classes of coal necessary. These are "best silkstone," "best Derby brights," "best kitchen," "best nuts," "kitchen cobbles," and "kitchen nuts." Experience will guide the buyer in making a selection of these to suit his particular neighbourhood. If he buy from the large companies locally he will be able to select and to make his terms without much trouble. If he own a wharf travellers from the various firms will call on him regularly, and prices (usually net at one month) are easily arranged. All the collieries, excepting the Welsh, allow 2 cwt.

extra per truck, which the railway companies carry free of charge, as allowance for occasional short weights. Coke nowadays is scarcely worth dealing in, especially in the metropolis, for the gas companies charge something like 10s. per chaldron for coke to the merchant and deliver free to the actual consumer for 6d. or 1s. per chaldron more. This is a standing grievance with the coal-dealers and the gas companies, and so far as the coalmen are concerned, the game is scarcely worth the candle under present conditions.

Prices and Profits. Three factors have to be considered in order to arrive at the net price of coal. These are the price at the pit's mouth, the carriage and the waggon hire. In the following table we give (1) the kinds of coal usually sold in London ; (2) the district from which they come ; (3) the average price per ton at the pit's mouth in summer ; (4) the rate of carriage per ton ; (5) waggon hire ; and (6) net cost in London :

Varieties.	Sources.	Average Price at Pit.	Carriage per ton.	Waggon Hire.	Net Cost in London.
		s. d.	s. d.	s. d.	s. d.
Best Silkstone ..	Yorkshire ..	9 0	7 2	1 0	17 2
Best Derby Brights ..	Derbyshire ..	8 3	6 0	1 0	15 3
Best Kitchen.. ..	Nottingham ..	7 9	6 3	1 0	15 0
Best Nuts	Derby	8 0	6 0	1 0	15 0
Kitchen cobbles ..	Leicestershire ..	7 3	5 3	1 0	13 6
Kitchen nuts.. ..	do. ..	7 0	5 3	1 0	13 3

In addition to these prices the cost of loading and cartage must be added. This works out at about 4s. per ton.

In retailing, fair summer and early autumn prices would average for these kinds 24s., 23s., 22s., 21s., 18s., and 18s. per ton respectively. After deducting ordinary working expenses, an average profit of from 10 to 20 per cent. may be reckoned on house trade in a carefully-watched business. When the business is of the select class, it will probably be necessary to stock the Durham coals, known in the trade as "Wallsend," but there is not so much of this now used in ordinary trade. The original Wallsend pits were worked out years ago. "Flockton Wallsend" and "Park Hill Wallsend" obtained from collieries in the district are recognised in the trade as "best Wallsends," mostly described as "best." These are the most expensive of all.

Provincial Trade. It will be understood, of course, that the prices and conditions are modified considerably in country districts and vary according to the season and the state of the market. Expenses generally will probably be less in many parts of the country, and in towns near the colliery districts less carriage will be demanded. But, of course, retail prices are proportionately smaller, and a fair average may be worked out all over the country at the profit on capital mentioned. The Scotch and the Welsh dealers have supplies from the collieries in their respective counties. Scotland is supplied by the coal-mines in the Glasgow district, in the Lothians, in Fife, and in Ayrshire, and the pit-mouth prices are much the same as those of the English collieries. Cardiff and Swansea are the great centres for the Welsh coal trade, and an enormous quantity of sea-borne coal is exported from these ports to all parts of the world.

CORN-CHANDLERS

The development of the side line, which seems to be the unavoidable issue in every kind of modern shopkeeping, is exemplified better, perhaps, in the establishment of a corn-chandler than in any other business. The original purpose of the corn-chandler was to deal in corn, fodder, etc., for horses and cattle, but nowadays, as the windows of any corn-chandler in a town of any size will show, proprietary foods, biscuits, mustards, rices, tapiocas, and other things naturally associated with the grocer, are almost the only articles shown. These things, although probably serving as an attraction, are still subsidiary to the main business—at least, so far as profits are concerned—for the backbone of the trade is the oats, wheat, flour, hay and straw that form the unobtrusive profit makers.

Experience. The successful corn-chandler usually emanates from agriculture or from an agricultural community. The son of a farmer, or of a miller, or the scion of some family interested in agricultural pursuits, has most often the proper natural bent for the business. But experience may be obtained, and, of course, has in all cases to be obtained, preferably by serving in the busy shop of some corn-merchant in a country town or in the suburbs of a large town with an agricultural district. To make a success of it the young man must set himself diligently to distinguish between the various kinds and qualities of oats, wheats, barleys, and so forth, to learn how and when to buy, and—as a doyen of the trade has observed—"there is a great art in learning how to measure." A little too much in the scale means loss of profit to the retailer ; on the other hand, short weight in a bag of oats raises the ire of the customer, and breeds suspicions difficult to allay. The successful corn-dealer must know the kinds and qualities of beans, peas, maize, and flour ; the way to cut and mix chaffs, the weight of trusses of hay, straw, etc., and the purpose and prices of the innumerable packed proprietaries that abound in the business.

Neighbourhood and Shop. Having acquired a thorough practical knowledge of these things, a man of good character and with £200 in the bank may bethink him of starting on his own account. He should be careful to select, if possible, a district where there are plenty of stables. He should make it his business to get acquainted with all the coachmen, livery-stable keepers, and team owners in the neighbourhood, regarding them as future sources of profit. The shop for the man with so limited a capital would be a small one, and should have a covered yard, or a store-room in connection,

for stocks of hay, straw, and other necessities that cannot well be kept in an open shop. In the suburbs of large towns like London, such premises would probably be obtained at from £50 to £70 a year rent, but in country towns a much smaller rental would suffice, and there would be other facilities which would make it easier for the beginner. But, taking a London suburb as an example, the rent mentioned would be a fair one, and as the fittings required —a few large bins, some shelving, a counter, etc. —are not elaborate, £25 would cover the preliminary preparations for stock.

Shop Requisites. There are, however, two sets of scales necessary—one of large size for weighing sacks, and smaller counter scales and weights. The former would cost, with weights, about £5 10s., and the latter £2 10s. Another £3 would be spent on measures and scoops of various sizes. The measures used are the bushel, half-bushel, peck, half-peck, two-quart, quart, pint, and half-pint. If particularly adventurous the beginner might also invest in a chaff-cutting machine, but he will probably find it preferable at first to buy his chaff ready cut. A supply of bags to hold about two bushels is also needed for displaying stock. These may be obtained from the wholesaler who supplies the goods, but they are usually charged sixpence each, and the careful man will lay in a stock of bags for his own use, buying them from a baker at a cost of about 1s. 6d. per dozen. Then he would require 40 corn-sacks (all with his name and address stamped on the side); these would cost on an average from 7d. to 8d. each. A like number of chaff-sacks, costing about 6d. each, are also necessary. This sack business is a serious matter in the corn trade if not carefully watched. Large numbers of sacks get lost in various mysterious ways, and as there is no recognised system of charging the customer for the sack in which he gets his corn, flour, or what not, the retailer often loses money in this way during the course of the year's trading. Paper bags of different sizes for small retail sales are obtainable with name and address printed on from any wholesale stationer at a few shillings per thousand.

Stock. An opening order would include a load of hay, £3 to £3 10s.; a load of straw, £1 10s. to £1 13s.; and a load of clover, £4 to £4 4s. A ton of chaff would likewise be needed, and five quarters of various qualities of oats, the cost price averaging about 18s. per quarter, except in the case of English oats, which would probably cost £1 3s. to £1 5s. Three or four sacks of various kinds of flour would be requisite, and one sack each of barley, maize, buckwheat, darii, wheat and barley. Then the buyer would have to make a careful selection from the innumerable proprietaries on the market, which it is necessary for him to stock, especially in a populous neighbourhood. He would probably mix his own poultry food and cattle foods, but there are many well-known brands of bird foods, poultry mixtures, dog biscuits, mustards, rolled oats, self-raising flours, and so on, that are in fairly frequent demand, and £20 judiciously laid out on these lines will make a good window show and lend a prosperous appearance to a new concern. Then there are supplies of oatmeal, rice, tapioca, mustard, butter beans, haricot beans, marrowfats, peas and lentils to be thought of, all of which would consume another £10 at least. In many country businesses corn and coal dealing often go together, but the combination is rarely, if ever, seen in big towns.

Credits and Profits. It must be understood that the inception of a business such as we have sketched can be undertaken with the capital named only on strictly cash prices for retail. The retailer will not be able to give any credit to his customers until he has a larger capital and a safe business, but he will, by careful management and intelligent buying, carry on business very well on cash lines. He will have no difficulty in getting supplies, as the representatives of corn-factors and grain merchants are as numerous and as eager for business as in other trades. The usual credit given by corn-factors is one month on the market prices, but no discount is allowed except in the case of some proprietaries. In the case of the latter a discount of 2½ per cent. off cost is in some cases obtained on goods paid for on delivery. The average gross profit cannot be reckoned at more than 20 per cent. on the return. There are no arbitrarily fixed retail prices for grain, fodder, etc., and the shrewd man adapts his prices to his environment. He will, of course, keep a keen eye on the corn markets, and there are many ways in which a skilful man will increase his profits. As business progresses he will be able to buy a chaff cutter, and perhaps even a pony and trap; and an intelligent interest in the needs of his neighbourhood, a strict attention to business, and fair dealing will secure him very soon a competence, if not an independence.

Continued

ALGEBRA

Simple Brackets. Simplifying Expressions in Brackets. Multiplication of Simple Expressions. Examples and Answers to Examples

continued from page 1820

By HERBERT J. ALLPORT, M.A

SIMPLE BRACKETS

18. As already explained, an expression that is to be treated as a whole is put between brackets. If we wish to *add* the expression to some other expression, we may enclose it in brackets and put the sign $+$ before the brackets.

Thus, $a + b + (2a - b)$ means that $2a - b$ is to be added to $a + b$. But we know that to add an expression to another, we simply write down all its terms, with their signs unchanged, after the other expression.

It follows, then, that *if a pair of brackets is preceded by the sign $+$, the brackets may be omitted.*

Again, if we wish to *subtract* an expression, we may enclose it in brackets and prefix the sign $-$. But, to subtract an expression, we write down all the terms, with their signs changed [Art. **16**.]

Therefore, *when a pair of brackets is preceded by the sign $-$, the brackets may be omitted if we change the signs of all the terms between the brackets.*

Thus, $a + b - (2a - b)$ is equivalent to $a + b - 2a + b$. For, the terms in the brackets are $+ 2a$ and $- b$, and, if we omit the brackets, we must change these into $- 2a$ and $+ b$.

19. Conversely, we have

Any number of terms of an expression may be enclosed within brackets with the sign $+$ prefixed, the sign of every term remaining unaltered.

Any number of terms of an expression may be enclosed within brackets with the sign $-$ prefixed provided the sign of every term put between the brackets be changed.

20. In simplifying an expression which has brackets placed within brackets, it is best to begin with the innermost pair, applying the rules given in Art. **18** to the removal of each pair.

Example. Simplify the expression

$$2b - [a - \overline{2a + b} + \{b - a - (-2b + 3a)\}]$$

The expression

$$\begin{aligned} &= 2b - [a - 2a - b + \{b - a + 2b - 3a\}] \\ &= 2b - [a - 2a - b + b - a + 2b - 3a] \\ &= 2b - a + 2a + b - b + a - 2b + 3a \\ &= 5a \text{ Ans.} \end{aligned}$$

EXPLANATION. The vinculum and pair of brackets ( ) contain no other brackets, so we remove these first. The sign before the vinculum is $-$, therefore the terms under the vinculum, *viz*, $+ 2a$ and $+ b$, will become $- 2a$ and $- b$ when the vinculum is removed. Similarly, since there is a $-$ sign before the brackets ( ), the terms $- 2b$ and $+ 3a$ will become $+ 2b$ and $- 3a$ when the brackets are removed. We next take the pair { }, simply having to write down all the enclosed terms, with their signs unaltered. We now remove the pair [ ], by changing the signs of the enclosed terms, since a $-$ sign precedes the bracket. Finally, we collect the like terms.

EXAMPLES 3

Simplify, by removing the brackets and collecting like terms

1. $2a - [b - \{a - (2b + a)\}]$

2. $3x - [1 - \{3x + (1 - \overline{3x - 1})\}]$

3. $a + b - [-(c - a) + \{2b - \overline{a + c}\}]$

4. $-\{-(1 - \overline{1 + 2})\} - [2 + \{1 - (2 + 3)\}]$

5. $x^4 - \{x - 3x^3 - (x^2 + x - 1)\} - [-3 - \{-x^4 - (3x^3 + x^2 + 1)\}]$

6. $\frac{1}{2}x - (\frac{3}{2}y + \frac{1}{4}z) - \{\frac{1}{2}x + (\frac{1}{2}y - \overline{\frac{1}{4}z + x})\}$.

MULTIPLICATION

21. In Arithmetic [Art. **15**] the multiplication of one whole number by another was defined to be the sum of as many repetitions of the one number as there are units in the other number. 12×5 means that we are to add together 5 repetitions of the number 12. We saw, however, on reaching fractional quantities [Art. **82**] that we had to put the definition in another form, *viz.*, to multiply one number by another we do to the one what we do to the unit to obtain the other. Thus, if we multiply 3 by 4, the definition states that since 3 is $1 + 1 + 1$, therefore, 3×4 is $4 + 4 + 4$.

By means of this definition we can find a meaning for multiplication by a negative quantity. Suppose we wish to multiply 3 by -4. To subtract 4 is the same as subtracting four units in succession, *i.e.*,

$$-4 = -1 - 1 - 1 - 1.$$

Hence, by definition, to multiply 3 by -4, we must subtract 3 four times in succession, *i.e.*,

$$3 \times (-4) = -3 - 3 - 3 - 3 = -12.$$

Similarly, we can multiply -3 by -4. For

$$-3 = -1 - 1 - 1.$$

Therefore,

$$\begin{aligned} (-4) \times (-3) &= -(-4) - (-4) - (-4) \\ &= 4 + 4 + 4 \text{ [Art. 18]} \\ &= +12. \end{aligned}$$

We can proceed in the same way with any other quantities, whether whole numbers or fractions, positive or negative. Hence, we see that

(i.) $a \times b = ab$,
(ii.) $a \times (-b) = -ab$,
(iii.) $(-a) \times b = -ab$,
(iv.) $(-a) \times (-b) = +ab$.

These four results are usually stated thus: *Like signs give $+$, unlike signs give $-$.* This is the *Law of Signs.*

22. It was proved in Arithmetic that $4 \times 5 = 5 \times 4$, and that $\frac{3}{5} \times \frac{4}{11} = \frac{3 \times 4}{5 \times 11}$. But $3 \times 4 = 4 \times 3$, and $5 \times 11 = 11 \times 5$. Hence

$$\frac{3}{5} \times \frac{4}{11} = \frac{4 \times 3}{11 \times 5} = \frac{4}{11} \times \frac{3}{5}.$$

Therefore, for *positive* values of a and b, whether a and b are whole numbers or fractions, we have

$$a \times b = b \times a.$$

But the result of Art. **21** showed that the *absolute* value of the product is independent of the signs, so that $ab = ba$ is true for *all* values of a and b, positive or negative.

It easily follows that

$$abc = a \times b \times c = (a \times b) \times c$$
$$= (b \times a) \times c = b \times a \times c = bac.$$

In the same way we get $abc = acb$, and so on. Hence, *the factors of a product may be taken in any order.* This result is called the *Commutative Law.*

23. From our definitions of *power* and *index* we have

$$a^3 = aaa \text{ and } a^4 = aaaa$$
$$\therefore\ a^3 \times a^4 = aaaaaaa = a^7 = a^{3+4}.$$

Again,

$$5a \times 3a^2$$
$$= 5 \times a \times 3 \times a \times a$$
$= 15aaa$, since the factors can be taken in any order
$$= 15a^3 = 15a^{1+2}.$$

Thus, *the index of the product of two powers of the same letter is equal to the sum of the indices of the factors.*

This result is called the *Index Law.*

24. Making use of the law of signs, the commutative law, and the index law, we are now able to find the product of any *simple* expressions, *i.e.*, expressions which contain only one term.

Example 1. Multiply $4x^2y$ by $3x^4y^2$.

$4x^2y \times 3x^4y^2 = 4 \times 3 \times x^2 \times x^4 \times y \times y^2$, by the commutative law
$= 12x^{2+4}\,y^{1+2}$, by the index law
$= \underline{12x^6y^3\ Ans.}$

Example 2. Multiply $7xyz^2$ by $-2x^2y$.

$7xyz^2 \times (-2x^2y) = -(7xyz^2 \times 2x^2y)$, by the law of signs
$= -7 \times 2 \times x \times x^2 \times y \times y \times z^2$, by the commutative law
$= -14x^{1+2}y^{1+1}z^2$, by the index law
$= \underline{-14x^3y^2z^2\ Ans.}$

We see, then, that the result can be written down at once, without putting down all the steps shown above. We (i.) write down the sign of the product; (ii.) multiply together the numerical coefficients; (iii.) write each letter that occurs, the index of its power being found by adding the indices of that letter in the factors.

Example 3. Find the continued product of $-3a^2b$, $2bc^2$, and $-4ac$.

$(-3a^2b) \times 2bc^2 \times (-4ac) = \underline{24a^3b^2c^3\ Ans.}$

In determining the sign, we see that the sign of the product of the first two terms is $-$. The sign of the product of this result and $-4ac$ will therefore be $+$.

EXAMPLES 4

Multiply

1. $4a^2$ by $7a^5$.	5. $-11ca$ by $-4ab$.
2. $-3x^3$ by $-4x$.	6. $2a^4b^6c$ by $-abc^3$.
3. xy by $-2xy$.	7. abx by bcy.
4. $3abc^3$ by $-2a^4c$.	8. $5cx$ by -4.

Find the continued product of

9. $4ab,\ -3ca,\ 5bc$.
10. $-a^3bcx,\ 2b^2x^2,\ 3ac$.
11. $-x^2yz,\ -y^3z^2,\ -x$.
12. $6byz,\ -4c^2xy,\ 2bz^2,\ ax^2$.

If $x = -2$, $y = 3$, $z = 0$, $a = -1$, find the value of

13. $2ax^2y$.
14. $5a^2y^3$.
15. $3xy + 4y^2z - 5a^3$.
16. $(2x + 3y)^2 - 3\,(a^2 + z^2)$.
17. $2ax - \{3x^2y - \overline{4xyz - a^3}\}$.
18. $\sqrt[3]{6ax^5y^2}$.
19. $\sqrt[3]{\dfrac{a^2 + xy}{5x^3}}$.
20. $\sqrt{6ax^3y} \div \sqrt[4]{12a^2x^2y^3}$.

Answers to Algebra

Examples 1

1. $3a^2 = 3\,.\,3\,.\,3 = 27$ *Ans.*

2. $4abc^2 = 4\,.\,3\,.\,1\,.\,2\,.\,2 = 48$ *Ans.*

3. $a^3 + b^3 + c^3 - 3abc = 3^3 + 1^3 + 2^3 - 3\,.\,3\,.\,1\,.\,2 = 27 + 1 + 8 - 18 = 36 - 18 = 18$ *Ans.*

4. $\dfrac{a + b - c}{a + c - b} = \dfrac{3 + 1 - 2}{3 + 2 - 1} = \dfrac{2}{4} = \dfrac{1}{2}$ *Ans.*

5. $\frac{1}{2}a^2b^2c^3 - \frac{1}{3}a^3bc = \frac{1}{2}\,.\,9\,.\,1\,.\,8 - \frac{1}{3}\,.\,27\,.\,1\,.\,2 = 36 - 18 = 18$ *Ans.*

6. $\sqrt{2x^2 + 3y^2 + 4z^2} = \sqrt{2\,.\,36 + 3\,.\,9 + 4\,.\,\frac{1}{4}} = \sqrt{72 + 27 + 1} = \sqrt{100} = 10$ *Ans.*

7. $\sqrt[3]{\dfrac{3xy}{z^2}} = \sqrt[3]{\dfrac{3\,.\,6\,.\,3}{\frac{1}{4}}} = \sqrt[3]{3\,.\,6\,.\,3\,.\,4} = \sqrt[3]{3^3\,.\,2^3} = 6$ *Ans.*

8. $\sqrt{x + y}\,.\,\sqrt[3]{x + 4y^2 + 7z^3} = \sqrt{6 + 3}\,.\,\sqrt[3]{6 + 4\,.\,9 + 7\,.\,\frac{1}{8}} = \sqrt{9}\,.\,\sqrt[3]{6 + 36 + \frac{7}{8}} = 3\,.\,\sqrt[3]{42\frac{7}{8}} = 3\,.\,\sqrt[3]{\frac{343}{8}} = 3\,.\,\frac{7}{2} = 10\frac{1}{2}$ *Ans.*

9. When $x = 3$, $x^2 - 7x + 12 = 9 - 21 + 12 = 21 - 21 = 0$. When $x = 4$, $x^2 - 7x + 12 = 16 - 28 + 12 = 28 - 28 = 0$. When $x = 5$, $x^2 - 7x + 12 = 25 - 35 + 12 = 37 - 35 = 2$.

10. $(ad + bc)^2 - 2\,(2a^2 - 3b^3) + (c^2d - 2b)^2 = (0 + 2)^2 - 2\,(32 - 24) + (0 - 4)^2 = 4 - 16 + 16 = 4$ *Ans.*

Examplfs 2

1. $ab + ca + bc$.	6. $-x^3 - 8x^2y + 5xy^2 - y^3$.
2. $-2x^3 - x^2 + x + 2$.	7. $-\frac{1}{6}a - \frac{7}{12}b + \frac{3}{4}c$.
3. $\frac{1}{2}x - y + \frac{1}{2}z$.	8. $-7a^4 + 3a^3 + a^2 + 3a - 4$.
4. $-2ax^2 - 2a^2x$.	9. $x^3 + 4x^2 + 2x - 2$.
5. $2ab - 3cd + 4bd$.	10. $4 - 3y - 4y^2 + 5y^3$.

Note. The answer to Examples **12**, No. 2 (page 886), should read as follows: $21{\cdot}923636 - 9{\cdot}3893 = 12{\cdot}534297702743247$.

Continued

THE MAKING OF FELT

Varieties and Uses of Felt. The Needs of the Industry. Felt Wools and their Treatment. Felting Machines and their Operation

Continued from page 1887

By W. S. MURPHY

FELT is a cloth which is not woven; felting may be described as the short cut to cloth manufacture. If all our fabrics were made by felting, we should have no spinning, no warping, no weft, no weaving. Felt cloth has neither warp nor woof; it is a solid layer of wool. Compare a piece of felt with a piece of woven cloth. Break up the structure of both, and note the differences between them. From the woven cloth threads come away from other threads with which they have been woven. In some cloths the combination of warp and weft has been so cunningly formed that we can separate them with difficulty; but, ultimately, they come apart as two sets of threads.

Distinctive Properties of Felt. If the felt be of good quality, you will not be able to fray it in the way the woven cloth has been done; but by pulling hard and perseveringly you get away something. It is not thread, but a little tuft of wool, with fibres irregularly displayed all round it, and the cloth shows a ragged hole. One peculiarity of felt is that you may break it, or cut it, but it can never be opened out. The fibres combine in ways designedly irregular, twining and twisting in all directions. Each fibre is warp and weft in one. Examining the tuft riven out, we see how the crinkled fibres of wool cling and mingle, the edges of the one holding on to the edges of the other. When studying the structures of wools, we noted the serrated edges characteristic of true wool. Useful in the making of yarns and threads, this quality is indispensable to the felt-maker. Whatever may be the quality of the wool used for making felt, it must possess that characteristic. Crinkling, curling wools are the best wools for the felt-maker; if they are also soft, lustrous, and sound, so much the better.

Varieties of Felt. Few fabrics have so wide a range of usefulness as felt. It enters into many departments of life. First, we view it as a headdress. The turban of the East seems to have been orginally a mass of fine wool beaten so as to fit the shape of the head, and protect it from the rays of the sun. Thence sprang felt caps, bonnets, and hats. [See HAT MANUFACTURE.] Another original felt was the blanket robe, of which the Roman toga was a refined survival, and the heavy robes of the American Red Indian actual examples. It is practically certain that the tent cloths of our nomadic ancestors were made of felted wool, and when the nomads settled down the fabric became mats for the floors and hangings for the doors of the dwellings. On these three lines the felt industry has developed—headdress, body apparel, and household garniture—ever growing with the expanding needs of civilised life.

Dress Felts. Leaving out for the moment the felt-hat industry, which is dealt with elsewhere, we look at the felts used in wearing apparel. Men do not use a large variety of felts. About the latter end of the nineteenth century, when an attempt was being made to break away from the prevalent sombreness of male attire, some fine felt coatings in various colours were put on the market, and enjoyed a short run of popular favour; but the dress reform movement died out, and the felt coatings passed out of fashion. For some classes of heavy overcoats, however, used principally by 'bus drivers, coachmen, and others working in all weathers, felt is largely used.

For the finer classes of felts the fair sex are good and constant customers, though fashion in the past favoured it more than at the present time. Felt drapes better than any other kind of heavy fabric, and hence it is a favourite material for riding habits, winter walking-skirts, long winter cloaks, and heavy jackets.

Household Uses. Foremost among the household uses for which felt is made comes the carpet. For one thing, felt carpets are cheap; a high quality can be produced at less cost than an inferior quality of woven carpet. They are artistic, easily laid and lifted, soft to the foot, and wear well. On the other hand, felt carpets lack the solidity and richness of the Brussels or Wilton, and do not imitate so closely the merits of the highest class of carpet as do the tapestry carpets.

Carpet felts perform a humbler, but not less useful, function than felt carpets. These are plain felts, generally of the natural colour of the wool, for laying under fine carpets and costly rugs. As a pad and protection, the felt is highly serviceable, and a very large trade is done in that line.

As a material for hangings and draperies, felt is greatly in demand. Still higher, and calling for more artistic ability, are the tablecloths, sofa rugs, mantel, and other draperies, made of felt, which have to compete with the fine products of the higher fabrics. Felt has a peculiar merit of its own for these purposes, having a fine, soft richness, combined with plainness, very attractive to the artistic eye.

Industrial Uses. Being in such demand as a household fabric, felt naturally comes into the hands of the upholsterer, and is utilised by him for all kinds of drapings, hangings, and coverings. Some of our very best work is done

for the upholsterer. Allied with him, though a specialist, is the billiard-table maker, for whom felts of the very finest quality are made. Few more difficult tasks are given to the felt-maker than satisfying the requirements of the billiard-table maker. The felt must be true in every inch of it, to a fraction of a hair.

The largest felts made are produced to the orders of the paper-makers. For their drying cylinders the paper-makers demand felts 9 ft. broad and of enormous length. [See PAPERMAKING.]

Saddlers use large quantities of felt. Horse-blankets, saddle-cloths, linings of saddles and collars, knee-cap pads, and other felts of various kinds are taken by the saddler and harness-maker.

Glass - workers demand special felts for polishing and buffing wheels. Felts 2 in. thick are not uncommonly required for these purposes.

Printing - machine blankets are generally made of felt. This market is one which is worthy of study. When it is remembered that indiarubber is the most formidable rival to felt in this line, the scope for the felt manufacturer is apparent. Rubber is not, and, perhaps, never can be cheap, and considerable care might be spent on producing an ideal felt cheap enough to leave a large margin between the cost of the one material and the other. The printing-machine blanket must be perfectly even, solid, smooth, and hairless.

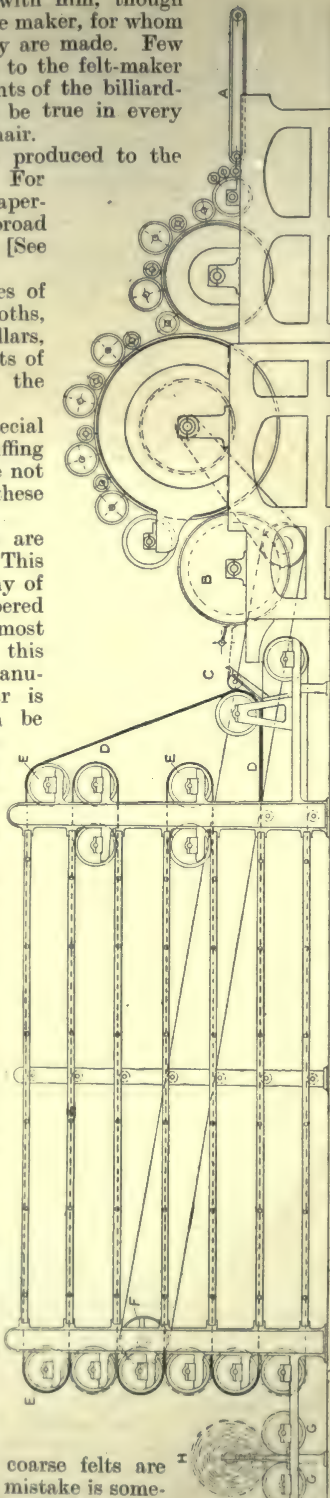
Plumbers and engineers use a considerable quantity of felt. Here, again, we encounter the competition of the rubber manufacturer. Handicapped as he is by a costly raw material, it is all to his credit that the rubber-worker has been able to cut so deeply into the trades once monopolised by the felt-maker. For certain purposes, such as water-tap washers and the like, it must be admitted that rubber can be made the superior material; but there are still many lines the felt-maker has allowed to slip into rival hands, which might be recovered by determined effort, to the benefit of both consuming industry and producing manufacture.

Large quantities of heavy, coarse felts are used in the building trades. A mistake is sometimes made by manufacturers in thinking that because they are asked to supply a coarse material, it need not be carefully made or of good quality. Some years ago a great contractor complained that genuine felt, suitable for his purposes, was not to be had. Asbestos has ousted felt from many lines in the building trades.

In many minor industries, or for minor purposes in great industries, felt is found useful, though not much notice is taken of the fact. In a sense, it is a kind of drudge. Industrial experimenters may be described as reasoning in this way: "Leather won't do, rubber won't do, woven cloth won't do; let us use felt."

Felt Manufacture. When felt became industrial, and emerged from the cottage into the factory, Leeds assumed the position of the chief trade centre. A great wool emporium, in the heart of the Yorkshire woollen manufacturing district, the town had many advantages for felt-making. While it would be unfair to suggest that felt-makers depend on the leavings of the wool market and the waste of woollen and worsted manufactures, there is no doubt that the felt industry usefully and profitably consumes those materials. The arrangement suited all parties, the wool brokers clearing out stock, and the cloth manufacturers getting rid of waste at fair prices, while the felt - makers obtained good material for their purposes at cheap rates. So it seemed that Leeds was the very best place possible for the successful establishment of the felt industry.

The Need for Water. But felt-making consumes enormous quantities of water; further, most felts are dyed and printed, and these processes require supplies of water almost unlimited. In a large town water is a very costly raw material; the free gift of river and rain must be gathered into vast reservoirs, and distributed through pipes, and the cost of these things are justly levied on the consumers of the water, generally in proportion to consumption above domestic needs. Leeds



73. SIDE ELEVATION OF SECOND CARDER AND BATT-FORMING MACHINE (Wm. Bywater, Leeds)

felt manufacturers, therefore, found it advisable to send their goods over to the Rossendale district of Lancashire, across the hills, where the dales are saturated with rain and intersected with rushing streams, there to be bleached, or dyed, or printed.

For a considerable period this division of labour worked very well; but when the railways began to cut into the lonely vales of East Lancashire, skirt round the mouths of the deep valleys, and even cross the wildest of them, a new spirit awoke. It occurred to one dyer and printer that wool might be as easily felted at Waterfoot as at Leeds, and the whole process carried through on one spot. The saving in carriage was something, the lower cost of living for the operatives another thing, and, in addition, and most important, the delays and inaccuracies inevitable in the best system of transit were wholly obviated.

The Centres of the Felt Industry. What happened was inevitable. By force of economic gravity the industry was drawn from Leeds into Lancashire, till Whitewell Vale and the neighbouring dales changed from lonely seats of isolated dyeing and printing establishments into scenes of busy manufacture. From Rawtenstall up to beyond Waterfoot the valleys are studded with felting factories, the works and the villages straggling for miles in every direction. In the higher classes of fine felts Leeds still enjoys a fair share of the trade, and Lancaster keeps hold of the old baize-cloth manufacture for which it made an enviable name in days gone by; but the bulk of the felt industry is carried on in the deep, rocky valleys which lie amid the hills bordering Lancashire and Yorkshire.

Outsiders may not see much difference between having raw material and goods carried to the factory and goods being taken to and from the finishers; but practical men know the difference.

In the first place, we have the stoppage of the process in mid-career, so to say, and the loss of impetus entailed in making a new start. Next, there are the repeated packings and unpackings. Add the accidental delays, entailing sometimes the loss of a day or more, and you have a fair idea of the disadvantages the Leeds felt-maker, who sent his goods to be dyed and printed in the Rossendale Valleys, had to combat.

As a rule, only one carding is given felting wools, and the sliver-forming apparatus is conspicuously absent. Instead, the carded wool is drawn off in the filmy web made by the doffing blade and wound round a roller. Felt wool never takes the form of a thread, not even such a remote semblance of a thread as a sliver.

Felt Wools. For making heavy felts and carpets we use large quantities of the short, crisp, and deeply-serrated wools of the East Indies. Carpet manufacturers of all classes find these wools almost indispensable; carpet weavers, as well as carpet felters, use them largely. Looking only at the low counts to which they can be spun, the inexperienced buyer might expect to buy them at his own price, but the market quickly clears his mind of that delusion. Harshness is certainly a characteristic of the Indian wools, and partly on that account, partly on account of the comparative costliness of the material, it is seldom used pure, except for special purposes. Some of the home wools, such as Highland, Blackface, and the coarser Leicesters, make a very good mixture with them, for either felts or carpet yarns. Nearly all the British wools felt well, and may be used pure or mixed, according to the kind and quality of wool felt designed.

We are about to touch on a matter regarded with some bitterness by many felt-makers, and even resented as a false imputation, though we have not been able to discover any reason for the feeling, nor any felting establishment where the imputation, if such it be, could be truthfully denied. Roughly put, the fact is that felt-makers utilise wools found unsuitable by worsted cloth manufacturers. This may sound a little harsh, but look at the facts. Weavers of high-class worsteds, broadcloths, and serges cannot utilise the higher sorting numbers of even fine merino fleeces. From No. 11 to 14 the wool is absolutely useless to them, and yet it is good and dear wool, useful in its way. What can they do but sell it, if they can find a market? The wool is sold, and it is bought by wise felt-makers, who have fine felts to make.

Noils. These wools are specially remarkable for high felting quality—that is to say, the material is better than even the wools designated the raw material of the felt manufacturer in the wool market. But this does not wholly describe the debt of the felt industry to worsted manufacture. In studying the combing process, we saw that a refuse called noils was left after the sliver had been formed. This remainder was carefully collected, not only to clear the combs, but for other purposes. We hesitate to call noils refuse, though rejected. The wool had already been selected by experts and put in the class of fine combing wools; but these fibres were rejected for one fault only—*viz.*, shortness. Comparatively little noil comes into the open market; as a rule, it is either utilised in another department of the factory or supplied by contract to a woollen cloth, a hosiery, or a carpet manufacturer, if the felt-maker is not smart enough to pick it up.

Perhaps the fact which felt-makers most desire to conceal is the function the industry plays to the sorting departments of the woollen factories. There are certain parts of the fleece which it would not pay to spin into yarn, but which make good felt. These wools are therefore bagged and sold to the felt-maker, but we can see nothing derogatory in that. On the contrary, we think it a noble act to make good felt out of what were otherwise waste material.

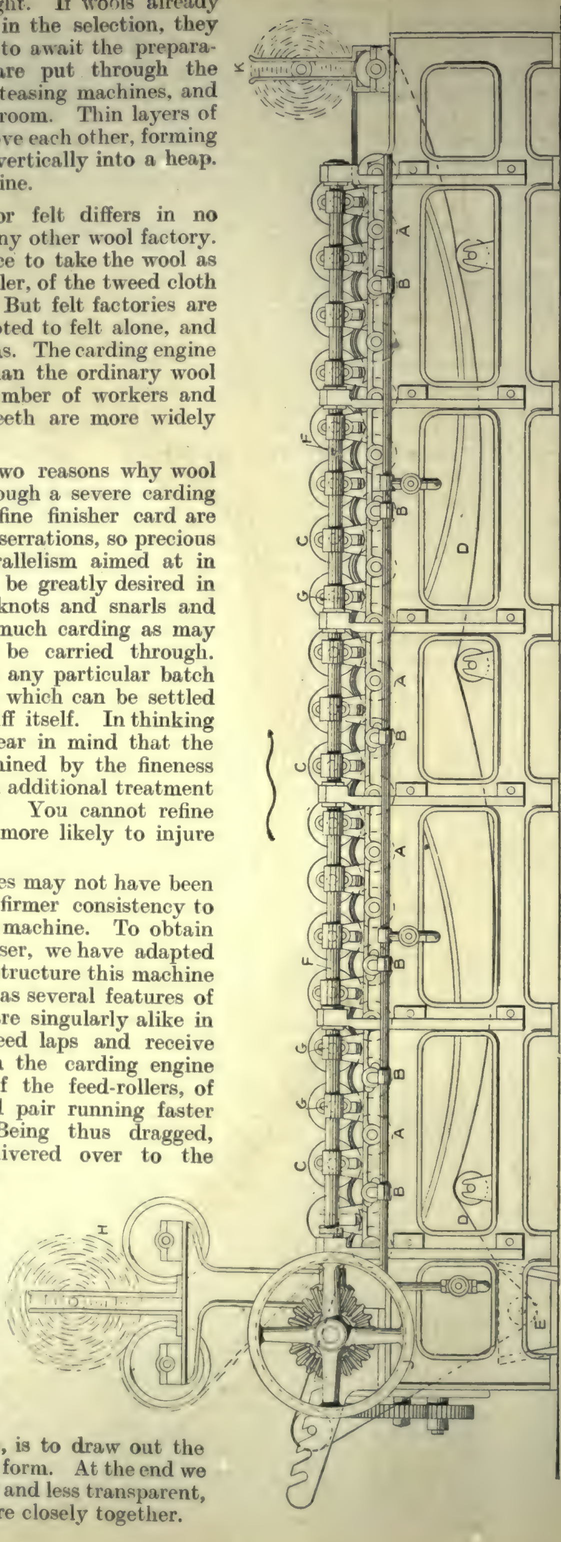
Preparatory. In felt manufacture the end of the process is designed from the beginning. Whatever may be the product aimed at—habit cloth, blanket, carpet, or paper-making felt—when we select the wool from the stores, we have it in mind, and make the selection accordingly. Once the process has begun, there is no turning back, no correcting of error, except

at great cost of time, labour and thought. If wools already prepared, such as noils, are included in the selection, they are sent on to the mixing room, there to await the preparation of the raw fibres. The latter are put through the scouring, drying, opening, burring, and teasing machines, and arrive, white and fluffy, at the mixing room. Thin layers of each material are piled horizontally above each other, forming a stack; then the whole is raked down vertically into a heap. Now it is ready for the carding machine.

Felt Carders. Carding wool for felt differs in no essential respect from the carding in any other wool factory. Indeed, it would be quite good practice to take the wool as it comes from the first carder, or scribbler, of the tweed cloth manufacturer, and make it into felt. But felt factories are usually individual establishments, devoted to felt alone, and the machines naturally take special forms. The carding engine of the felt-maker is generally larger than the ordinary wool carder, and equipped with a greater number of workers and strippers; sometimes, too, the card-teeth are more widely set, and do not slant so sharply.

Limit to Carding. There are two reasons why wool designed for felt should not be put through a severe carding process. First, the keen teeth of the fine finisher card are apt to tear away the imbrications, or serrations, so precious to the felt-maker. Secondly, the parallelism aimed at in the higher carding processes is not to be greatly desired in felting. Of course, we want all the knots and snarls and little mats to be taken out, and as much carding as may be necessary for that purpose must be carried through. What amount of carding is needed for any particular batch of wool is a purely practical question, which can be settled only on the spot and in view of the stuff itself. In thinking out that question, the worker should bear in mind that the fineness of the felt is primarily determined by the fineness of the wool of which it is composed, and additional treatment affects the ultimate result very little. You cannot refine coarse wool by fine carding; you are more likely to injure it and reduce its value.

Scutching. The mixing of the fibres may not have been thorough, and we may wish to give a firmer consistency to the wool before laying it on the felting machine. To obtain a finer mixture and bring the fibres closer, we have adapted the scutcher to our need. In its main structure this machine is simply the cotton scutcher, but it has several features of its own. Feed end and delivery end are singularly alike in appearance; the reason is that we feed laps and receive laps. The filmy laps are taken from the carding engine and hung in tiers of four in front of the feed-rollers, of which there are two pairs, the second pair running faster than the first, or outermost, pair. Being thus dragged, the wool is torn asunder, and delivered over to the beaters revolving within the machine over the slanted or curved grid, dropping out the remaining dust and rubbish. Underneath stretches a moving lattice, inclined up towards the lapping rollers. Blown flat upon the lattice by the exhaust fans, the wool is carried forward to the lapping rollers, similar in action to those of the cotton scutcher, but revolving more rapidly, or, being larger in circumference, having a quicker surface speed. The object of the lap machine, in the present instance, is to draw out the wool to its former fineness, but in a firmer form. At the end we have again four webs, or laps, but thinner and less transparent, because the fibres have been pressed more closely together.



74. SIDE ELEVATION OF ROLLER FELTING MACHINE. (Wm. Bywater, Leeds)

Making the Finest Felts. This method produces the very finest of felts; those laps could be formed into felts as fine as the finest calico. It is not often we are called upon to make felts of that quality, however. But the scutcher, or *bat-engine*, as it is named in the felting trade, can be adjusted to form laps as thick or as thin as may be required. Lower the speed of the lapping rollers by a half, and we get a lap equal in thickness to two of the four fed in at the beginning; make the speeds equal, and the lap will be equal to all four put together. Add to the number of carded laps, and the thickness will be greater; slacken the draft of the lapping rollers till it becomes negative instead of positive, and the lap grows correspondingly thick.

The Common Batt Frame. We have already hinted that present-day practice tends towards shortening the felting process. In **73** we show one of the latest methods of forming what is called the "batt," or thick sheet to be felted. By this method, the wool is formed into a sliver on the second carder, and run direct on to the batt-forming frame. From the scribbler, the wool comes on to the feed sheet A of the second carder, and passing through, comes out on the doffing roller, B, to be formed into the sliver C. Round the rollers of the batt frame, E, runs an endless canvas web, D, driven from the carder by the belt F. Upon the web the sliver travels round and round, gathering layer on layer, till a thick sheet is formed and wound on the rollers, G, whence it is made into the roll, or batt, H, and ready for the felting machine.

Felting. Anybody can make a piece of felt. Take a handful of damp wool, spread it out in a thick layer on a board, and knead it together with the hands. After a short time, the fibres which were formerly a loose mass will be found combined into a flat cake of wool more or less coherent. By diligent practice and experiment, careful observation of the manner in which the fibres act under the rolling pressure of the hand, and acquirement of the deftness in adjusting the pressure needed, one might make a piece of real felt. Our privately made felt would not be of much use; but the experiment is useful, as teaching the primary basis of a very important industry. Advance a step further. The early felt-makers used a mallet and a piece of raw hide in the following way. Spreading the heap of washed wool on a flat stone, and covering it over with the hide, the felter beat upon the wool with the mallet. The hide gave an obliquity to the strokes, which the worker aided by giving it a rolling movement. Between the strokes of the mallet and the rubbing movement, the wool was spread flat and wrought together in quite a wonderful manner, forming an even piece of cloth. We have no need to go back to such primitive methods; our wool is already formed into a fine, flat web; but our aim is just the same as that of the early felt-maker with his stone, raw hide, and mallet, and if he could produce good felt, as he did, surely we may hope to achieve that purpose too.

A Simple Machine. One of the simplest machines in the felt factory is the water felter. A shallow trough, nearly full of warm water, heated by steam coils laid along the bottom, forms the main body of the machine. At one end are the feed-rollers, and geared within the sides of the trough are two sets of rollers, the under set being wholly submerged in the water, and the upper set merely touching the surface. The submerged rollers are hollow tin or copper cylinders, filled with steam, and those above are heavy wood rollers. It is important to note the relative positions of the rollers. The upper set do not lie directly above the lower set, but each wooden roller rests between two cylinders, touching the sides rather than the tops of the cylinders. The gearing of the rollers is also peculiar. The sockets of the spindles are movable, and geared on an eccentric apparatus which imparts to them a backward and forward motion. Naturally, a roller slung on these sockets is bound to have a transverse action, no matter at what speed it may be run. These are the main features of the machine, and, having got a fair notion of the structure and mechanism, we are ready to work it.

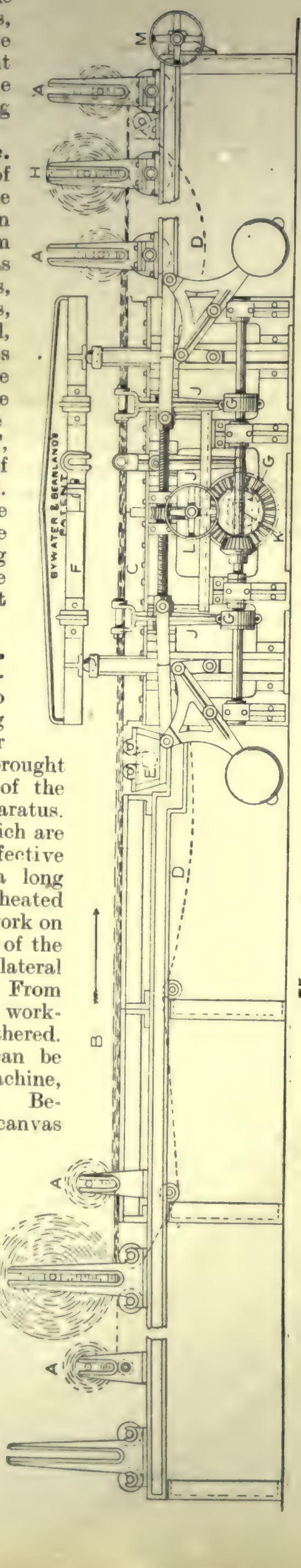
Working the Water Felter. The web of wool is slung on the end of the machine, and the end, gently led forward by the endless web of canvas, falls on a cylinder, which bears it round to meet the heavy wooden roller revolving on the inner side of the cylinder. Roller and cylinder turn in the same direction, but the motion is slow, and the upper rollers have a transverse action, caused by the oscillating sockets on which they are slung. The revolutions of the rollers draw the canvas web and the wool forward on to the next cylinder. The wool is not only held firmly and pressed by the cylinder, but the oscillating movement rubs the fibres together, causing them to combine in the closest unity. The warm water, by softening and slackening the fibres, causes them to cling together, and aids in the felting process. Through from three to six pairs of felting rollers the wool passes, growing firmer and more consistent, and what was once a soft web issues a fine, solid piece of felt. Few manufacturing processes are so quickly effective as this. No matter what has yet to be done to it, this is a veritable fabric, and might well be worn as a blanket by an Indian, or used as a bed-mat by any civilised person. It is cloth. Wound on to a beam through squeezing rollers, which press out the water, the felt is now ready for further treatment.

Though a very simple machine, some care is required in the working of it. For one thing, felts are not all of one thickness, and the setting of the cylinders and rollers determine what thickness the felt is to be. Another fact to be noted is that wools have a limit to their capacity for refinement in felting just as in yarn. Indian wool cannot be spun to a higher count than 10's and produce sound thread; neither is it wise to attempt producing a very fine felt with that wool. The felt-worker may be led to fancy he does not need to study the yarn capacities of wool, but

this is a mistake. The same principle governs all fabrics, whether woven or felted. The wool which spins to a high count of yarn will also felt into a fine cloth—that is, if it be a felting wool.

Roller Felting Machine. Fig 74 shows the side elevation of a roller felting machine of the most modern construction. In this machine there are bottom rollers of iron, AA, as well as steam-heated copper cylinders, BB, to support the wooden rollers, CC, pressing down upon the wool, which is borne on the endless sheet, D, passing through the water trough, E, and between the two sets of rollers. One of the eccentric shafts is denoted by FF, and the eccentrics at the end of each roller are shown by GG. Controlled by two rollers, the sheet H descends into the machine beside the driving pulley, J, along the endless web, D, through the felting rollers, emerging as felt at K.

Table Felting Machine. Roller felting produces a disturbing effect upon the wool. To obviate this, a flat table felting machine, known as the Bywater & Beanlands patent has been brought into use. The principal feature of the machine is the flat felting apparatus. It is composed of two plates, which are wrought upon the felt in an effective manner. Over the trough of a long machine is placed a flat, steam-heated table, and above it, set so as to work on whatever may be on the surface of the table, is an iron plate, to which lateral and transverse motion is given. From 75 a good general notion of the working of this machine may be gathered. As many as six batt sheets can be felted on the flat table felting machine, though only one is shown at H. Between each layer of wool a canvas sheet, A, would be put to keep them separate. But here we have the felt being formed into one thick fabric. Over and under the tables, an endless web, D, is run through the trough of water, E. The first table, B, first receives the wool on to its steam-heated and moist surface, and then, moistened and heated, the sheet passes on to the hardening table, C. Above the table is the hardening plate, F. By means of the pulley, L, the plate is raised or lowered,



75. TABLE FELTING MACHINE. (Wm. Bywater, Leeds)

and the transverse and lateral motions are given to the top hardening plate by the eccentrics, GG, and the connected levers, JJ. K is the driving shaft and pulley for the top plate, and M is the pulley which winds up the sheets. The action of this machine is alternate and automatic. When the felting has continued for the prearranged time, the top plate lifts; the felted portion moves onward, and a fresh portion of batt comes into place to be felted. As soon as the fresh piece is measured out, the top plate descends, and the felting begins again. In this way absolute uniformity of texture is secured.

Sulphuric Treatment. Low-class felts are sometimes mixed with flax or other vegetable fibres, but the higher grades are made absolutely free from all such matters. Even very good wools, as we know, are not always wholly free from burrs and other vegetable matters. In very fine felts, especially those which are dyed, the presence of even minute burrs would be highly inconvenient. To render that accident impossible, the felts are subjected to a bath in a weak solution of sulphuric acid. This process, while mechanically simple, calls for the utmost care, because one of the actions of sulphuric acid, if left unchecked, is the destruction of the felting property of wool. The solutions supplied to the trade, however, and the methods which have become traditional in practice, render that danger almost non-existent in the hands of the careful worker. Taken from the bath, the felt is thoroughly cleared of the acid by washing, and it is then in condition for further preparation.

Carpet felts, felts for linings, for builders, and many other industrial and domestic purposes, are allowed to retain their natural colour. Carpets, draperies, habit cloths, and all the higher classes of felts, are variously dyed and printed in colour and pattern. [See DYEING; also CALICO PRINTING.] Felt is finished in the same way as many other fabrics. The methods and machinery used in the finishing of textile fabrics are studied in a later stage of this course.

Continued

COOKERY RECIPES

Methods of Preparing, and Ingredients for, Various Puddings and Sweets, Savouries, Sauces, and Salads

continued from page 1875

PUDDINGS

Winchester Pudding

INGREDIENTS. Three ounces of rice, one pint of milk, a quarter of a pound of raisins, three ounces of candied peel, two eggs, two ounces of suet, a little lemon rind, a dust of nutmeg.

Method. Wash the rice well, put it in a pan with the milk, and let it cook very slowly (with the lid on the pan) till all the milk is absorbed. Stone and chop the raisins, also chop the peel and suet. Mix all these ingredients together, and add the sugar, rind, and nutmeg. Have ready a buttered basin, put in the mixture, cover it with a piece of greased paper, and steam it gently for two hours. Turn it on to a hot dish, and serve with it any nice sweet sauce.

Apricot Cream

INGREDIENTS. Half a pint of cream, half a pint of apricot purée, one ounce of leaf gelatine, one teaspoonful of lemon juice, a little jelly, two ounces of castor sugar.

Method. Rinse out a pretty mould with cold water, then coat it all over with clear wine or lemon jelly. Rub the contents of a small tin of apricots through a sieve. Melt the gelatine in a gill of water, then add to it the sugar and lemon juice. Whip the cream till it will just hang on the whisk. Strain the gelatine, etc., into the purée, and lastly add the cream, stirring it in very lightly; if liked, add a few drops of cochineal to it. Pour it into the mould, and leave it till set. Then dip the mould into tepid water, shake it gently, and turn the cream on to a pretty dish.

Peaches may be used instead of apricots.

Fruit Tart with Short Crust

INGREDIENTS. Two pounds of plums, four tablespoonfuls of sugar, three tablespoonfuls of water, half a pound of flour, six ounces of butter, lard, or dripping, half a teaspoonful of baking-powder, a pinch of salt.

Method. Wash and stalk the plums, half fill the pie-dish with the fruit, then put in the sugar, and lastly the rest of the fruit, piling it up as it will sink when cooked; pour in the water. Sieve together the flour, salt, and baking-powder; next shred and rub in the butter, then add enough cold water to make it into a paste. Roll it out on a floured board to the shape of the dish, but slightly larger. Cut off a strip the width of the lip of the dish; wet the pie-dish, put on the strip of pastry, brush that with water, then put on the lid, pressing the edges together. Crimp the edges neatly. Bake the tart in a quick oven for about three-quarters of an hour.

Any fruit may be used in the place of plums, but the amount of sugar must be varied according to the kind of fruit.

Plum Pudding

INGREDIENTS. One and a half pounds of chopped beef suet, one pound of breadcrumbs, one pound of currants, one pound of raisins, one pound of sultanas, one pound of mixed peel, one pound of brown sugar, half a pound of almonds, a quarter of a pound of cornflour, two nutmegs, four lemons, ten eggs, one gill of brandy, one gill of milk.

Method. Clean and prepare the fruit, and chop it finely. Mix all the dry ingredients together. Beat up the eggs, add the brandy and milk, and stir these into the dry ingredients, mixing them well. Put the mixture into well-buttered moulds, and cover them with scalded and floured cloths; put them in a pan of fast boiling water, and let them boil steadily for ten hours. Keep them in a cool, dry place till they are required.

Orange Fritters

INGREDIENTS. Two or three oranges, castor sugar, four ounces of flour, one gill of tepid water, one tablespoonful of salad oil, the whites of two eggs, a pinch of salt.

Method. Sieve together the flour and salt. Make a hole in the middle of the flour, and stir into it smoothly the oil and water. Beat the whites of the eggs to a stiff froth, and add them lightly to the batter. Let the batter stand while the oranges are being prepared. Peel them, remove all the pith, and divide them into sippets. Have ready a deep pan of frying fat; when a bluish smoke rises from it dip the sippets of orange in the batter, and then drop them into the fat, and fry them a pretty golden brown. Drain them well on paper. Sprinkle over them castor sugar, and serve them piled up on a lace paper.

Any kind of fruit may be used, such as apples, apricots, or peaches.

Pineapple Soufflé

INGREDIENTS. Three ounces of flour, two ounces of butter, half a pint of milk, the yolks of three eggs and the whites of four, three ounces of tinned pineapple.

Method. Melt the butter in a pan, stir in the flour smoothly, add the milk, and stir the mixture over the fire till it forms a ball in the pan; then add to it a dessertspoonful of pineapple syrup, and stir it over the fire for a minute or two. Then separate the yolks and whites of the eggs, add the yolks one by one to the mixture, with the sugar, and the pineapple cut into neat dice. Whip the whites to a very stiff froth, then stir them very lightly into the mixture. Pour it into a buttered soufflé mould, which has a band of buttered paper tied round it coming four inches above the top. Lay a piece of buttered paper across the top of the band, and steam the soufflé gently for one and a half hours. Then turn it out, and pour round the pineapple syrup, which should first be made hot.

Ginger soufflé is made in the same way.

Wine Jelly

INGREDIENTS. One and a quarter pints of hot water, half a pint of sherry, half a pound of loaf sugar, two ounces of leaf gelatine, the shells and whites of two eggs, three lemons, one inch of cinnamon.

Method. Put all the water, wine, sugar, and cinnamon into a clean, bright steel or enamel pan. Pare the lemons thinly, add the rinds and the strained juice to the other ingredients. There should be a quarter of a pint of juice. Next put in the gelatine, and lastly wash the egg shells, crush them small, and add them; whisk the whites of the eggs stiffly, and add them also. Put the pan over the fire, and whisk with an egg whisk till the contents begin to boil. Take out the whisk and let the mixture boil up to the top of the pan. Draw the pan to one side, put on the lid, and let it settle for ten minutes. While it is settling, turn a chair upside down on the kitchen table, tie a clean glass-cloth to the legs, place a basin under the cloth. Pour some boiling water through the cloth to heat it; empty it out of the basin, then gently pour the jelly into the cloth. When a little has run through, slip another basin in the place of the first, and put the jelly back into the cloth to re-strain it. Continue re-straining it until it is quite clear, then pour it into a mould which has first been rinsed out with boiling water then with cold. If liked, the mould can be set with any kind of fruit.

Apple Amber

INGREDIENTS. Two pounds of apples, three ounces of Demerara sugar, the rind of one lemon, three eggs, an ounce of castor sugar, a quarter of a pound of any kind of pastry, and some glacé cherries.

Method. Peel, core, and slice the apples, put them in a saucepan with the sugar and the grated rind of the lemon. Let them stew gently till they are tender, then rub them through a sieve. Roll out the pastry and lay a strip of it round the top of the pie-dish, having first brushed the dish with a little water. Separate the yolks and whites of the eggs, beat up the yolks, then add them to the apple pulp; pour this mixture into the dish; ornament the border with little stars of pastry, which should be brushed with water before being laid on. Bake it in a moderate oven for about fifteen minutes. Meanwhile, beat the whites of the eggs to a very stiff froth, heap it up roughly over the top of the pudding, sprinkling it as you do so with castor sugar. Decorate it with a few glacé cherries. Put it in a cool oven till the meringue is set and just slightly tinted.

Banana Trifle

INGREDIENTS. Eight bananas, eight sponge cakes, one lemon, half a pint of cream, half a pint of milk, two eggs, castor sugar, raspberry jam, angelica, and a few glacé cherries.

Method. Peel the bananas and cut each in four. Cut each cake in four, and make the pieces up into little sandwiches with the jam. Put the milk in a pan on the fire and bring it to the boil; beat the eggs, pour the milk on to them, sweeten the custard to taste. Pour it in a jug, put the jug in a saucepan with boiling water to come halfway up it. Stir it over the fire till the custard thickens; it must not boil or it will curdle. Let it get cold. Put a layer of the cake in a glass or silver dish, pour over some custard, next put a layer of bananas, then a little grated lemon rind; then more cake and custard, and so on till all the ingredients are used. The trifle should be as dome-shaped as possible. Lastly, pour on the rest of the custard. Whip the cream, flavour and sweeten it to taste, then heap it roughly all over the trifle. Decorate it prettily with glacé cherries and shreds of angelica.

Peaches, apricots, pineapples, or oranges may be used in the same way.

Meringues

INGREDIENTS. The white of four eggs, half a pound of castor sugar, cream, and a little salad oil.

Method. First, prepare the board—if you have no special one, use an ordinary pastry one—brush it over slightly with salad oil, then cover it with a piece of foolscap paper; brush this also over with oil. Separate the yolks and whites of the eggs, putting the whites into a large basin. Sieve half a pound of fine castor sugar. Whisk the whites of the eggs to a very stiff froth, then stir in the sugar as quickly and lightly as possible with a wooden spoon. The mixture is now ready for shaping. Choose two dessert spoons the same size, fill one with the mixture, then with the other scoop it neatly out on to the prepared board. They should have an egg-like appearance. As they are shaped put them on the board an inch from each other. Put the board in a very cool oven for them to dry slowly; they must be only tinted the palest straw colour. They will probably take about an hour. Lift them carefully off the board with a knife, turn them over, press the soft part inside the shells very gently with the finger. Put a clean piece of paper on the board, put the meringues on it with the underside uppermost and dry that also. They are then ready. They will keep any length of time in a tin box. Do not put in the cream till just before they are wanted. Whip the cream stiffly, flavour and sweeten it to taste, fill each half, then press them together. Pile them up on a glass dish and serve.

Pancakes

INGREDIENTS. Four ounces of flour, half a pint of milk, one egg, a quarter of a teaspoonful of salt, one lemon, lard for frying.

Method. Put the flour and salt in a basin and mix them well; make a hole in the centre of the flour, pour in two tablespoonfuls of milk and the egg, and stir them with a wooden spoon round and round. Add more milk, until all the flour is mixed in and half the milk is used, then beat it well with a wooden spoon till the surface is covered with bubbles; next add the rest of the milk, and, if possible, let the batter stand for an hour. Melt about two ounces of lard in a small pan; have ready a small frying-pan, pour about a teaspoonful of the melted lard into it, and when a faint smoke rises, pour in enough batter to thinly cover the bottom of the pan. Fry till it is a golden brown underneath, shaking it gently now and then to make sure it is not sticking, then toss it over and fry the other side. Slip the cake on to a piece of sugared paper, taking care to lay the side that was first fried on

the paper. Shake over a little castor sugar and a squeeze of lemon juice, roll up the pancake neatly, and keep it hot while the others are being fried. Serve them as quickly as possible garnished with slices of lemon.

A Salad of Fruits

INGREDIENTS. A small tin of apricots or peaches, a small tin of pineapple chunks, three bananas, two oranges, half a pound of black grapes, one ounce of pistachio nuts, the juice of a lemon, castor sugar to taste, one small bottle of white wine.

Method. Peel and slice the bananas, peel the oranges, and scrape off all the pith; then divide them into sippets and cut each sippet in two or three pieces. Cut the pineapple and apricot into dice. Blanch, shell, and shred the pistachio nuts. Put all the fruits in a salad bowl, strain in the lemon juice, add the wine and sugar to taste. Cover the bowl, and let the salad stand an hour. Serve it as cold as possible.

In summer leave out the pineapple and add instead a quarter of a pound each of raspberries, red currants, strawberries, and cherries.

SAVOURIES

Croûtes à la Parisienne

INGREDIENTS. A small jar of German caviare, green butter, anchovy butter, two or three slices of bread an eighth of an inch thick.

Method. Stamp the bread into small rounds with a plain cutter, and fry them a pretty golden brown in butter. Let them get cold. Next, arrange a small heap of caviare in the centre of each round. Pipe round it a border of anchovy butter, and lastly, round the edge of the croûton, pipe a border of green butter. Arrange the croûtons on a lace paper.

The anchovy butter is made by mixing together two boned anchovies, two ounces of butter, and a dust of cayenne. These are rubbed through a sieve and coloured prettily with a few drops of anchovy essence.

Green butter is made by boiling three handfuls of spinach, draining it well, and pressing it through a sieve; the fluid is then mixed with two ounces of butter, a teaspoonful of chopped parsley, and salt, pepper, and lemon juice to taste. It should be a pretty shade of green.

Stuffed Olives

INGREDIENTS. Slices of white bread, a small bottle of stoned olives, anchovy paste, anchovy butter.

Method. [For anchovy butter see Croûtes à la Parisienne.] Stamp out small rounds of bread with a plain cutter, and fry them a pretty brown. Let them cool, then spread a thin layer of anchovy paste on each croûton. Place a stoned olive in the centre; fill the centre of each olive with some anchovy butter, and put a neat border of it round the edge of each croûton. Put a tiny sprig of parsley on each olive. Arrange the croûtons on a lace paper.

The croûtons should be about an inch and a quarter, or less, across.

Hâtelets de Fromage

INGREDIENTS. One ounce of semolina, half a pint of milk, salt and pepper, two yolks of raw eggs, one ounce of Parmesan cheese.

Method. Boil the semolina in the milk till it is thick enough to stand alone, season it with pepper and salt. Then add to it the yolks of two eggs and the Parmesan cheese; stir the mixture over the fire for a minute or two to cook the yolks. Spread the mixture on a plate; it should be half an inch thick. When it is cold, stamp it into rounds, with a cutter the size of a shilling. Cut half a pound of Gruyère cheese into rounds the same size, place these rounds alternately on a short skewer, beginning and ending with the cheese; there should be three rounds of cheese and two of semolina on each. Brush these over with beaten egg, and cover them with white crumbs, then fry them a pretty golden colour in hot fat. While they are hot, draw the skewers out carefully. Pile the hâtelets upon a hot dish, and serve them at once.

Cheese Custard

INGREDIENTS. Two ounces of grated Parmesan cheese, one ounce of grated Gruyère cheese, two whites and three yolks of eggs, salt and cayenne to taste, one and a half gills of cream.

Method. Beat the eggs together without frothing them, then whip the cream and add it, also the cheese, salt, and cayenne to taste. Be sparing with the salt, as some cheese contains so much Well butter a soufflé case, and put in the mixture—it should come about half way up. Place the case in a baking tin with water in it, and bake it in a quick oven till it is just set and a delicate brown. Serve it at once or it will sink.

Devilled Prawns

INGREDIENTS. Two or three dozen prawns (according to size), a little flour, cayenne, two teaspoonfuls of chopped parsley.

Method. Shell the prawns. Toss them lightly in the flour. Put them in a frying basket and shake off all the loose flour. Have ready a pan of deep frying fat; when a bluish smoke rises from it, plunge the frying basket into the fat and fry them a nice brown. Drain them on kitchen paper. Dust them over with cayenne, sprinkle the parsley over them, and serve them on a lace paper garnished with cut lemon and parsley. Shrimps and whitebait can be treated in the same way.

Cheese Aigrettes

INGREDIENTS. A quarter of a pound of flour, one ounce of butter, half a pint of cold water, two eggs, three ounces of any stale cheese, cayenne.

Method. Put the flour on a tin in the oven for a few minutes, to dry it, then pass it through a sieve. Put the water and butter in a pan and bring them to the boil; then throw in the flour, and stir this mixture over the fire until it will leave the sides of the pan clean. Let it cool slightly, then add the eggs, one by one, beating them well in. Grate the cheese finely, and add it with some cayenne, and, if necessary, a little salt as well. Spread the mixture on a plate to cool. Have ready on the fire a pan of deep frying fat—it is best to wait till a faint bluish smoke rises from it—then take it off the fire to cool slightly. Now take a teaspoonful of the mixture, drop it into the fat and let it fry a golden brown. Drain it on paper. When all are fried, serve them very hot, sprinkled with cheese. They may be re-heated in the oven, and will keep a long time in a tin box.

SAUCES

Bread Sauce

INGREDIENTS. Half a pint of milk, two cloves, half an ounce of butter, two tablespoonfuls of bread-crumbs, one small onion, salt and pepper.

Method. Peel the onion, then stick the cloves into it. Put the milk, onion, and cloves into a saucepan on the fire. While it is boiling, rub some stale bread through a sieve till you have two tablespoonfuls. When the milk boils, sprinkle in the crumbs ; add half an ounce of butter, and let it all simmer gently for about ten minutes. Season it nicely to taste. Take out the onion and cloves, and serve the sauce in a hot tureen.

Bearnaise Sauce

INGREDIENTS. Four shallots, one gill of white sauce, three ounces of butter, half a gill of tarragon vinegar, half a gill of malt vinegar, three eggs, one teaspoonful of chopped chervil and tarragon, salt and pepper.

Method. Chop the shallots finely, put them in a saucepan with the vinegars. Boil these with the lid off the pan till they are reduced to half, then add the white sauce [see Melted Butter Sauce], whisking it all the time till it is very hot ; add one by one the yolks of the eggs, whisking them in briskly. On no account let it reach boiling point. Next draw the pan to the side of the stove and whisk in the butter a little at a time till all is used. Strain the sauce through a fine strainer, add the tarragon and chervil, reheat it very gently, then serve it in a hot tureen.

German Sauce

INGREDIENTS. Two yolks of eggs, a glass of sherry, castor sugar to taste.

Method. Put all the ingredients into a small saucepan and whisk them quickly over a slow fire till the mixture is all froth. On no account must it be allowed to boil, or it will curdle. Serve it at once.

Melted Butter Sauce

INGREDIENTS. One and a half ounces of butter, one ounce of flour, three quarters of a pint of either milk, milk and water, or milk and stock.

Method. Melt the butter in a saucepan, stir in the flour smoothly, then add the liquid a little at a time ; stir it over the fire till the sauce boils well and thickens.

Having once made the foundation, a great variety of sauces may be made with slight additions.

For plain melted butter, add salt and pepper.

For sweet melted butter, add sugar.

For parsley sauce, add two teaspoonfuls of chopped parsley.

For caper sauce, add two teaspoonfuls of capers.

For anchovy sauce, add two teaspoonfuls of anchovy essence.

For shrimp sauce, add a gill of picked shrimps.

For onion sauce, add two large onions (chopped).

For egg sauce, add one or two hard-boiled eggs.

Tomato Sauce

INGREDIENTS. Half a pound of tomatoes, one onion, one carrot, a small bouquet of parsley and herbs, a few bacon trimmings, half a teaspoonful of cornflour, salt, pepper, and castor sugar, one gill of stock or water.

Method. Peel and slice the carrot and onion, put these in a saucepan with the bacon, and fry them gently ; slice and add the tomatoes, also the herbs. Stir these over the fire for a few minutes, then pour in the stock, bring it to the boil, and let it boil for twenty minutes, or till the vegetables are tender. Next rub all through a sieve, put the sauce back in the saucepan, make it quite hot, add the cornflour mixed with a little cold water and salt, pepper, and sugar to taste. This is a delicious accompaniment to chops, steaks, and grills of all kinds.

Brown Sauce

INGREDIENTS. One small carrot, one small turnip, one small onion, two ounces of butter or beef dripping, one and a half ounces of flour, one pint of stock, salt and pepper.

Method. Wash and prepare the vegetables and cut them into thin slices. Melt the butter in a saucepan ; when it is quite hot, put in the vegetables and fry them a good brown. Next, shake in the flour and fry it a pale brown. Now add the stock, or water with a little meat extract will do. Stir all together till the sauce boils, then draw the pan to the side of the fire and let it simmer gently for half an hour. Skim it well. Strain out the vegetables, and season the sauce carefully. Half a glass of Marsala would be a great improvement, but it is not necessary.

SALADS

French Salad

INGREDIENTS. Three lettuces, one endive, a handful of young dandelion leaves, one teaspoonful each of chopped thyme, mint, and parsley, two hard-boiled eggs, one small beetroot, salad dressing.

Method. Wash the lettuces, endive, dandelion leaves, and parsley. Pull them into convenient-sized pieces. Mix them all together in a salad bowl. Garnish with the eggs and beetroot, cut in slices, and hand with it some good salad dressing.

Beef Salad

INGREDIENTS. Half a pound of cold beef, a small beetroot, a quarter of a pound of tomatoes, two lettuces, two hard-boiled eggs, a clove of garlic, one gill of salad dressing.

Method. Cut the meat into long thin shreds. Wash and prepare the lettuces. Skin the beetroot, and boil the eggs for fifteen minutes. Next cut the eggs, beetroot, and tomatoes into dice, and the lettuces into small pieces. Mix half of the lettuce with all the other ingredients. Press the mixture into a pudding basin which has been rubbed over with the garlic, leave it for a few minutes, then turn the basin downwards on a glass or silver dish. Give it a gentle shake and lift the basin carefully up, leaving the salad behind. Arrange the rest of the lettuce leaves in a border round, and, if liked, decorate with a few slices of tomatoes.

Continued

PRACTICAL SOLID GEOMETRY

Solids in More Difficult Positions. Sections made by Vertical, Horizontal, and Inclined Planes. True Shapes of Sections

By WILLIAM R. COPE

Solids with Sides Inclined to Both Horizontal and Vertical Planes

453. A Cube, Standing on One Edge, with its Vertical Faces Inclined to the V.P. at 35°, and its Sloping Faces Inclined to the H.P. at 45°. First draw the plan and elevation when the vertical faces are parallel to the V.P., as in **421**. Turn the plan thus found so that *hf* makes 35° with *XY*, and project to meet the parallels from *a'b'c'd'* for the elevation.

454. A Cube, when the Plane of One of its Faces is Inclined to the H.P. at 35°, and at Right Angles to the V.P. Draw the plan *aBCD* when the cube stands with its face in the H.P., and project the points of this face to *XY*. Draw *a'c'* at 35° with the H.P. (*i.e.*, with *XY*), and rotate *B'* and *C'* into it, thus obtaining *b'* and *c'*. Draw perpendiculars to *a'c'* at *a'*, *b'*, and *c'*, making them each equal to *BC* (an edge of the cube). Join *e'* and *g'*, which completes the required elevation. Draw projectors from *a'*, *b'*, *c'*, *e'*, *f'*, *g'*, to meet horizontals from *a*, *B*, *C*, and *D*, for the required plan.

Additional Projections from the Same Plan. Very often different views of an object from other standpoints are necessary to explain its true form. These views may be easily obtained by *changing the position of the intersection line XY* instead of drawing a fresh plan; and much time and labour is thereby saved. Problem **453** might be solved in a similar manner as explained in **455**.

455. A Rectangular Prism with a Square End in the H.P., and One Face Parallel to the V.P. Also Draw a Second Elevation when One of its Vertical Faces makes an Angle of 30° with the V.P. First draw the square *abcd* for the plan as shown, and project from it for the elevation *a'b'f'e'*. Then draw *X'Y'* at 30° with *XY* (as if *XY* were turned until it made 30° with its original position—*i.e.*, at 30° with the original V.P.). Projectors from *abcd* perpendicular to *X'Y'* will give the required second elevation as shown. The heights *a''e''*, etc., are the same as *a'e'*, etc.

456. An Equilateral Triangular Prism with its Ends Parallel to the V.P. and One Rectangular Face in the H.P. Also, a Second Elevation when the Axis is Inclined at 60° with the V.P. First draw the triangle *a'b'c'* for the elevation, and project from it for the plan. From this plan draw projectors (for the second elevation) perpendicular to *X'Y'*, which is at 60° with *XY*, or with the V.P. The line *f''c''* is the same height from *X'Y'* as the point *c'* is above *XY*.

457. A Hexagonal Prism with One of its Sides in the H.P., and its Ends Parallel to the V.P. Also, a Second Elevation when the Axis is Inclined at 45° with the V.P. Proceed as in **455** and **456**. Begin with the regular hexagon *a'b'c'd'e'f'*.

The Circle, Cone, Cylinder, and Sphere

458. A Circle in a Plane which is Vertical and Parallel to the V.P. The elevation is the circle *a'b'*, and its plan the line *ab*, projected as shown.

459. A Circle in a Vertical Plane which is Inclined to the V.P. at 50°. For the plan draw *ab* at 50° with *XY*, upon it describe a semicircle, and divide it into any convenient number of equal parts (say four) at *C*, *D*, and *E*. Draw perpendiculars from *C*, *D*, and *E*, to meet *ab* in *c*, *d*, and *e*, from which draw projectors perpendicular to *XY*. Make *c'c'* equal to *ab*, and bisect it by a horizontal line for the points *a'* and *b'*. Set off a distance equal to *eE* or *dD* on each side of *a'b'* to obtain the points *e'*, *e'*, *d'*, and *d'*. Draw the ellipse through the points thus obtained, which completes the elevation.

460. A Cone, Lying with its Side in the H.P., and its Axis Parallel to the V.P. First draw the plan and elevation when standing upright with the base in the H.P. Then *ABbC* is the plan, and *A'F'b'* the elevation. Rotate the latter, so that *b'F'* is on *XY* and the point *A'* at *a'*, then *a'b'f'* is the required elevation. Project from *a'*, *b'*, *c'*, *f'*, to meet horizontals from *A*, *B*, *C*, and *F*, for the plan.

461. A Cylinder, with its Axis Inclined at 20° with the H.P. and Parallel to the V.P. Also, Another Elevation when Viewed from the Left at Right Angles to its Original Position. The elevation is an oblong *a'b'c'd'* with *a'b'* inclined at 20° with *XY*. For the plan, describe a semicircle on *a'c'*, divide it into, say, four equal parts, and draw parallels to *a'b'* through each division, to meet *a'c'* and *b'd'* in *e'*, *f'*, and *g'*. From each of these points project perpendiculars to *XY* to intersect *bc* and the other lines drawn parallel to *XY*, and thus obtain the ellipses as in **459**.

For the *side elevation* draw *V'P'* perpendicular to *XY*, for the side elevation of the V.P. Place *a''d''* (the centre line) as far from *V'P'* as *bc* of the plan is from *XY*. Also place *e''g''*, etc., similarly. This is best done by taking *P'* as centre and rotating the points as shown by curved dotted lines to meet *XY*. Draw perpendiculars from these points in *XY* to meet the horizontals from first elevation. Complete as shown.

462. A Cone, with its Base Inclined at 60° with the H.P., and its Axis Parallel to the V.P. Also, a Second Elevation when the Axis is Inclined at 45° with the V.P.

AND ITS BASE, AS BEFORE. 60° WITH THE H.P. Draw $a'b'$ at 60° with XY and equal to the diameter of the base. Bisect it in c', draw $c'f'$ perpendicular to $a'b'$, and equal to the axis or height of the cone. Join $a'f'$ and $b'f'$. Then $a'b'f'$ is the elevation. For the plan, describe a semicircle on $a'b'$, and divide it as before. Draw a centre line af at a convenient distance parallel to XY. Draw projectors from a', b', c', d', e', f', set off the ordinates on both sides of af, and draw the ellipse and sides of the cone.

For the second elevation, draw $X'Y'$ at 45° with XY, and project perpendiculars to $X'Y'$ from each point in the plan. Draw $c''c''$ parallel to $X'Y'$, and the same distance from it as c' is above XY. Each of the points a'', d'', etc., is respectively the same distance from $X'Y'$ as a', d', etc., is above XY. Complete as shown.

463. TWO SPHERES, WHOSE RADII ARE AS 3 : 1, LYING IN CONTACT WITH EACH OTHER ON THE H.P., AND THE LINE JOINING THEIR CENTRES BEING PARALLEL TO THE V.P. Draw one circle (say, the smaller) on XY for the elevation of one sphere. Draw its vertical diameter, and produce it so that Ab' is equal to the sum of the radii of the two spheres. With b' as centre and $b'A$ as radius, describe an arc Aa' to cut a horizontal line drawn at a distance from XY equal to the radius of the other (larger) sphere, in the point a'. With a' as centre describe another circle for the elevation of the other sphere. For the plan draw projectors, and complete as shown. The line ab must be parallel to XY in this case.

Sections

An architect often wishes to show the internal construction of a building; or an engineer the inner works of a machine. To represent this we must imagine the building or machine to be cut through by a vertical or horizontal plane, and a drawing made of the cut or *section*. This drawing would indicate the position, arrangement, and thickness of the walls, floors, etc.; or similarly the parts of the machine.

It is usual to represent the section or cut part of the object by a series of parallel lines making an angle of 45° with the intersecting line XY.

Care should be taken to distinguish between the *sectional plan and elevation* and the *true shape* of the section. The *sectional plan* is the appearance of the object when viewed vertically from above, and the upper portion removed; the *sectional elevation* is the appearance when viewed horizontally forwards, and the front part removed; the *true shape of the section* is seen when the section is looked at perpendicularly to the plane of section. Sometimes a part of the portion removed is indicated by dotted lines for clearer explanation.

Sections made by Vertical Planes Parallel to the V.P., or by Horizontal Planes Parallel to the H.P.

464. GIVEN THE PLAN $cfde$ OF A CUBE CUT BY A VERTICAL PLANE ab, DRAW THE SECTIONAL ELEVATION. Project from c, f, d, e, for the elevation, making $c'c'$, etc., equal to the edge of the cube, and join. From a and b draw projectors to the elevation for the section, and $a'a'b'b'$ is the section or cut part. In this case, as also in Problems **465** to **468**, the *true shape* of the section is shown, because we are supposed to be looking perpendicularly at the section.

465. THE ELEVATION OF A SPHERE CUT BY A HORIZONTAL PLANE $d'e'$ IS GIVEN. DRAW THE SECTIONAL PLAN. Project from c' the centre, and from a' and b' the ends of the horizontal diameter through c', to c, a, and b, and describe the outer circle for the plan. From d' and e' draw projectors to meet ab in d and e. With c as centre and cd as radius describe the inner circle for the section.

466. THE PLAN OF A HEXAGONAL PYRAMID IS GIVEN, AND IS CUT BY A VERTICAL PLANE hk. DRAW THE SECTIONAL ELEVATION. Draw projectors from each point, fix g' at a height above XY equal to the height of the pyramid, and join the points. For the section draw projectors from h and k to meet XY in h' and k'. Join $h'g'$ and $k'g'$, then $g'h'k'$ is the sectional elevation.

467. THE PLAN $abcd$ OF A CYLINDER IS GIVEN, AND IS CUT BY A VERTICAL PLANE ef. DRAW THE SECTIONAL ELEVATION. Draw projectors and obtain the elevation of the solid. To obtain the width $e'e'$ or $f'f'$ of the section, draw a semicircle on ad, then eg is half the width of the section. Set off $a'e'$ equal to eg on either side of $a'b'$ to obtain the points e', e', f', f'.

468. THE ELEVATION $a'b'c'$ OF A SQUARE PYRAMID IS GIVEN, WITH ONE OF ITS TRIANGULAR FACES IN THE H.P. AND ITS AXIS PARALLEL TO THE V.P. IT IS CUT BY A HORIZONTAL PLANE $d'e'$. DRAW THE SECTIONAL PLAN. Draw af at any convenient distance parallel to XY, and project from a', b', and c', for the plan, making cg and bh each equal to $b'c'$, an edge of the square base. For the section draw projectors from d' and e', then $ddee$ is the sectional plan.

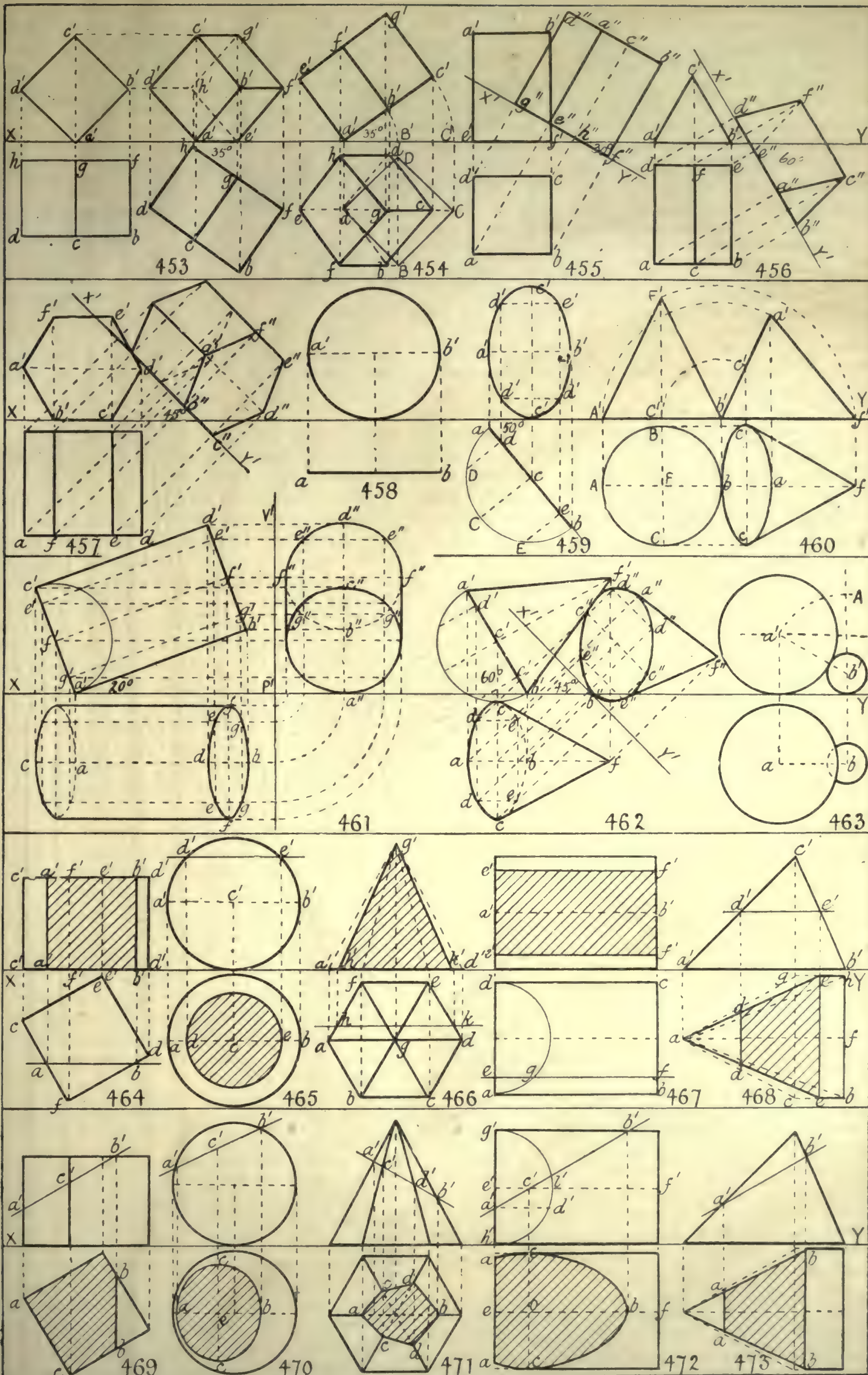
Sections made by Planes Inclined to the H.P., but Perpendicular to the V.P.

469. THE ELEVATION OF A CUBE IS GIVEN, AND IS CUT BY A PLANE $a'b'$ INCLINED TO THE H.P., BUT PERPENDICULAR TO THE V.P. DRAW THE SECTIONAL PLAN. Draw projectors and obtain the plan of the cube. The section is easily obtained as shown.

NOTE. In **469** to **473** the sections are not their true shape, because we are not looking perpendicularly to the section plane.

470. THE ELEVATION OF A SPHERE IS GIVEN, WHICH IS CUT BY A PLANE $a'b'$ INCLINED TO THE H.P. DRAW THE SECTIONAL PLAN. Obtain the plan of the sphere as in **465**. Bisect $a'b'$ in c'. Draw the projectors from a', b', and c'. Make ec equal to $a'c'$ or $b'c'$. Draw the ellipse through $acbc$ for the section.

471. THE ELEVATION OF A HEXAGONAL PYRAMID IS GIVEN, AND IS CUT BY A PLANE $a'b'$ INCLINED AT 30° TO THE H.P. DRAW THE SECTIONAL PLAN. Obtain the plan, and draw



SOLIDS IN MORE DIFFICULT POSITIONS. SECTIONS MADE BY VERTICAL AND HORIZONTAL PLANES

projectors from a', b', c', d', for the plan of the section as shown.

472. Given the Elevation of a Cylinder, which is Cut by a Plane $a'b'$ Inclined at 30° to the H.P. Draw the Sectional Plan. Obtain the plan, in which draw the centre line ef for the plan of the axis. To obtain the width ea of the section, upon $g'h'$ describe a semicircle, and through e' draw $e'f'$ parallel to XY for the elevation of the axis, which is cut by the section plane in c'. Through a' draw $a'd'$ parallel to $e'f'$, then $a'd'$ is the width of half the section at the left-hand end of the cylinder. Draw projectors from b' and c'. Make ea (on both sides of ef) equal to $a'd'$, also oc, oc, each equal to $e'l'$, which is half the width of the section at c'. Draw the curve through a, c, b, c, a, and join aa, which completes the sectional plan.

473. The Elevation of a Square Pyramid is Given, Lying as in **468**, and is Cut by a Plane $a'b'$ Inclined to the H.P. at 30°. Draw the Sectional Plan. Obtain the plan as in **468**. Draw projectors from a' and b', and complete the sectional plan as shown. The dotted lines in plan indicate the upper portion removed.

How to Find the True Shape of a Section

474. A Cube Stands with One of its Faces in the H.P. and a Vertical Face Inclined at 30° to the V.P. The Cube is Cut by a Plane $a'b'$ Inclined at 75° with the H.P. and Perpendicular to the V.P. Draw the Plan, Elevation, and True Shape of the Section. Draw the plan of the cube, so that the edge ef is inclined at 30° with XY, and project the elevation. Then draw the section plane $a'b'$ so that it cuts the cube at an inclination of 75° with XY. (As no definite position of the cutting plane is indicated in the data, $a'b'$ may be drawn anywhere through the elevation, as long as it is inclined at 75° with XY.) Draw projectors from a' and b' to the plan, then if the left hand portion be removed, $aagbb$ is the sectional plan.

To obtain the *true shape* of the section, project at right angles from each point a', g', and b', where the section plane cuts the elevation, and transfer the widths of the section from the plan; thus, make $b''b''$ equal to bb, $a''a''$ equal to aa, etc., then $a''a''g''b''b''$ is the true shape of the section. Or project from the plan and transfer the distances from the elevation, so that $h'''g'''$ is equal to $b'g'$, and $g'''l'''$ equal to $g'a'$, then $a'''a'''g'''b'''b'''$ is the true shape of the section. In the first method it should be noticed that $m''n''$ is equal to mn, and $a''m''$ equal to am. It is not necessary to use both methods, only the one which is most convenient.

475. A Square Prism, with its Axis Horizontal, but Perpendicular to the V.P., and a Face Inclined at 25° to the H.P. is Cut by a Vertical Plane ab Inclined at 45° to the V.P. Draw the Sectional Elevation and the True Shape of the Section. Draw $b'c'$ at 25° to XY, and construct the square for the elevation of the object. Project from each corner for the plan of the same. Draw ab (anywhere in this case, so long as it makes 45° with XY), and project from a, c, d, b, to the elevation, so as to obtain the sectional elevation $a'a'c'b'd'$. For the true shape of the section, draw horizontals from a', a', c', b', d', and at any convenient distance, in order to avoid confusion, draw $a'''e'''$ parallel to $a'a'$. Make $e'''c'''$ equal to ac, $c'''f'''$ equal to cd, $f'''g'''$ equal to db, and through f''' and g''' draw parallels to $a'''e'''$ to intersect the horizontals. Join $a'''a'''c'''b'''d'''$ for the true shape of the section.

Another Method to Obtain the True Shape of the Section. Draw $X'Y'$ at any convenient distance from, and parallel to, ab. Project from a, c, d, b, perpendicular to $X'Y'$. Make the points a'', a'', c'', b'', d'' respectively the same height above $X'Y'$ as a', a', c', b', d' are above XY. Join the points thus obtained, and $a''a''c''b''d''$ is the true shape of the section.

As students often find the projecting of these sectional views somewhat troublesome, it would be a good help to draw the complete elevation of the object on $X'Y'$, and either rub out the removed part, or represent it by dotted lines as shown in **475**.

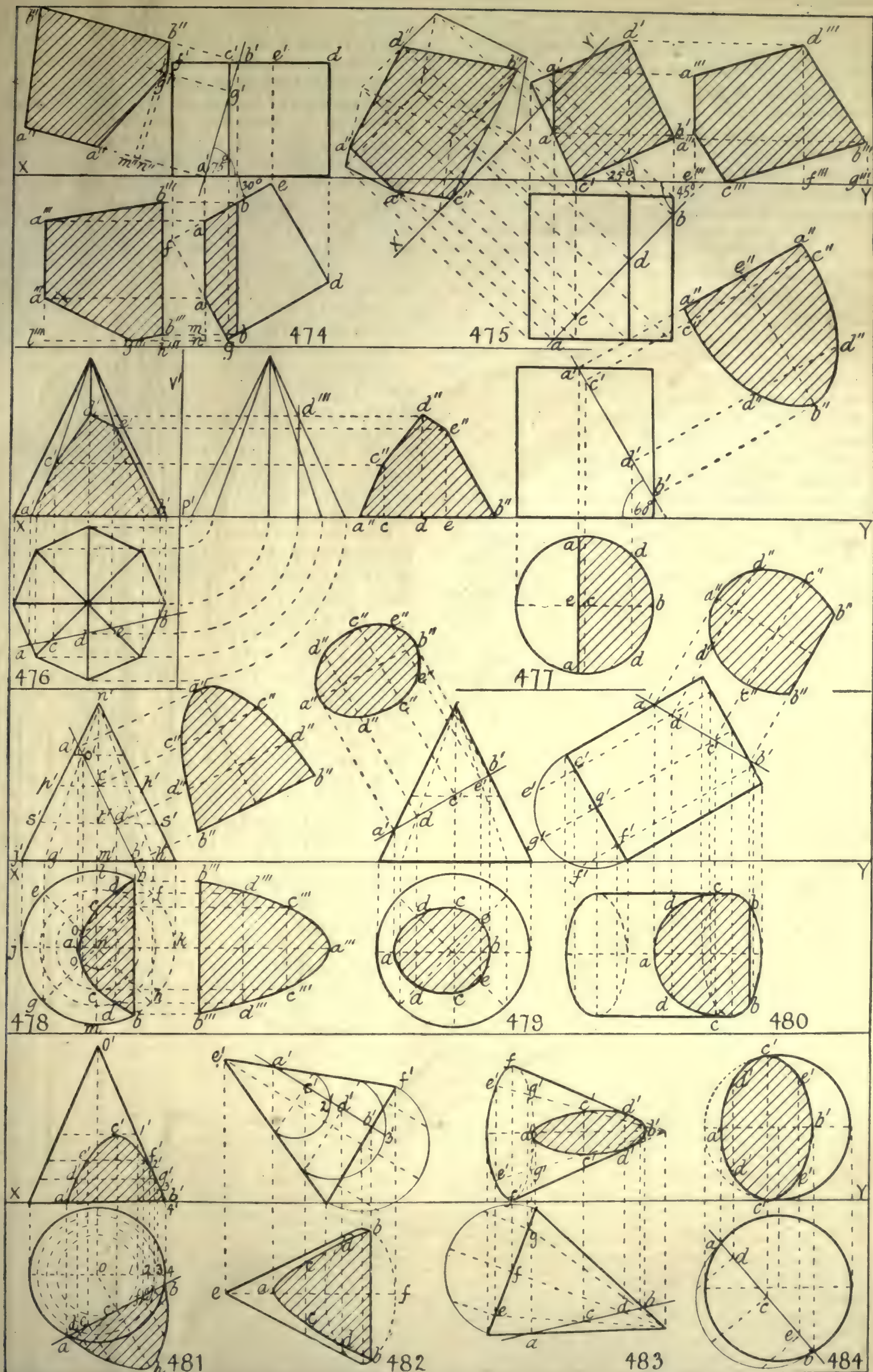
476. Given the Plan of an Octagonal Pyramid Cut by a Vertical Plane ab. Draw the Sectional Elevation, and True Shape of the Section. Draw the elevation, and project from the points a, c, d, e, b to determine a', c', d', e', b' in the elevation. Join the latter points, and the sectional elevation is complete. The elevation of the point d' is obtained by drawing a side elevation of the pyramid, projecting from d to $V'P'$, turning d into XY, and erecting a perpendicular to meet the outside edge of the pyramid at d'''. Through d''' draw $d'd'''$ parallel to XY to fix the point d' in the sectional elevation.

To obtain the true shape of the section, set off on XY, $a''c$ equal to ac, cd equal to cd, etc., erect perpendiculars from c, d, e, to meet horizontals from c', d', e'. Join the points a'', c'', d'', e'', b'', which give the true shape required.

477. The Elevation of a Cylinder Standing on One End is Given, which is Cut by a Plane $a'b'$ Inclined at 60° with the H.P. Draw the Sectional Plan, and the True Shape of the Section. The plan of the cylinder is a circle. Project from a', and complete the sectional plan as shown.

To obtain the true shape of the section, find the centre c of the circle, and take any convenient points d, d, in the circumference. Project from c, d, and d, to $a'b'$, the elevation of the cutting plane. Draw a centre line $b''e''$ at any convenient distance from and parallel to $a'b'$. Project from a', c', d', b', make $a''a''$ equal to aa, $c''c''$ equal to the diameter through c, and $d''d''$ equal to dd. Draw the curve through the points thus obtained, and $a''b''a''$ is the true shape required.

478. Given the Elevation of a Cone Standing on its Base, and Cut by a Plane



SECTIONS MADE BY VERTICAL AND INCLINED PLANES

$a'b'$ PARALLEL TO ITS SIDE. DRAW THE SECTIONAL PLAN AND TRUE SHAPE OF THE SECTION. The plan of the cone is a circle, in which draw the diameter *jk* parallel to XY, and the other diameters *eh, fg, lm*, so as to divide the plan into (say, eight) equal parts. Obtain these lines on the elevation, then the section plane cuts them in the points a', o', and c'. Point a' is on line $j'n'$, therefore its plan is on *jn* at *a*, as projected; point o' is on line $g'n'$, and its plan is therefore on *gn* at *o*; and the corresponding point on the further side of the cone is on *en* at *o*. As point c' cannot be projected vertically, as regards the distance of its plan on either side of *jk*, through c' draw $p'p'$ parallel to XY, to represent the elevation of a horizontal section through c', then $c'p'$ is the distance of *c* from *jk* on either side. Also, we do not know how far the plan of d' is both sides of *jk*. Therefore, imagine a horizontal section through d', then $s's'$ is its elevation, and $t's'$ is the distance of *d* from *jk* in the plan. Point b' is on the circumference of the base, and therefore its plan is on the circle at *b*. Draw the curve through *b, d, c, o, a, o, c, d, b*, and join *bb*, which completes the sectional plan.

The plan of the points o', c', and d' might be found by drawing circles for the plan of each horizontal section through those points, then projectors from each point to meet the circles respectively will give the plan of each point as shown.

For the true shape of the section two methods are shown, which are constructed similarly to the method used in **475** and **477**. The diagrams will now be easily understood.

479. THE SAME AS **478**, BUT CUT BY A PLANE $a'b'$ NOT PARALLEL TO THE SIDE, BUT INCLINED TO THE H.P. AT 30°. Draw the plan and divide it into any number of (say, eight) equal parts as before, and proceed as in the previous problem **478**.

The true shape is easily obtained as shown. Notice that $c''c''$ is equal to *cc*, $d''d''$ to *dd*, etc.

480. THE ELEVATION OF A CYLINDER IS GIVEN, AND IS CUT BY A PLANE $a'b'$ INCLINED TO THE H.P. AT 30°. DRAW THE SECTIONAL PLAN AND TRUE SHAPE OF THE SECTION. Obtain the plan as in **461**. On the elevation describe a semicircle (which is half the true shape of the end), and divide it into (say, four) equal parts. Draw parallels to the elevation of the axis from each point in the semicircle. From a', d', c', b', draw projectors to the plan. Make *dd* equal to twice $e'e'$, *cc* twice $g'g'$, etc. Draw the curve and complete the sectional plan as shown.

The method of finding the true shape is similar to that in the preceding problems.

481. THE PLAN OF A CONE CUT BY A VERTICAL PLANE *ab* IS GIVEN. FIND THE SECTIONAL ELEVATION AND THE TRUE SHAPE OF THE SECTION. Draw the elevation and project the points *a* and *b* to XY. Then obtain the height of the section. Draw *oc* at right angles to the section line *ab*, and describe a circle with centre *o* and radius *oc*. From 1 the point where the circle cuts *o*4, project to the elevation for 1′. Through 1′ draw a horizontal line to represent the elevation of the circle, and project from *c* to meet this line at c', the highest point in the section. Obtain other points in the curve by taking points *d* and *e*, and describe circles through them from *o* as centre. Project from 2 and 3, where these circles cut *o*4, and draw their elevations at 2′ and 3′. Projectors from *d, e, f, g*, to meet these elevations of circles give the points d', e', f', g'. Draw the curve and complete.

For the true shape of the section make the perpendicular *ch* from *c* equal to the height of c' above XY, and the perpendiculars at *d, e, f, g*, equal to the heights of the respective points d', e', f', g', above XY.

482. THE ELEVATION OF A CONE CUT BY A PLANE PARALLEL TO THE AXIS IS GIVEN. DRAW THE SECTIONAL PLAN. Obtain the plan as in **462**. Project points a' and b' for *a* and *bb*. For other points take c' and d', and draw sections parallel to the base. The semicircles on these lines give half the true shape of the sections at these points c' and d'. Project from c' and d', and set off on each side of the centre line *ef* of the plan a distance equal to $c'2'$, and $d'3'$ for the points *cc* and *dd*. Draw the curve and complete as shown.

483. THE PLAN OF A CONE WITH ITS AXIS HORIZONTAL IS GIVEN, AND IS CUT BY A VERTICAL PLANE *ab*.

484. THE PLAN OF A SPHERE CUT BY A VERTICAL PLANE *ab* IS GIVEN. DRAW THE SECTIONAL ELEVATION IN EACH CASE.

The diagrams explain themselves for these two problems.

Continued

WHAT PSYCHOLOGY IS

The Science of the Mind. Its great Names and its great Questions. The Origin of Ideas. Growth of the Mind and the Brain

By Dr. C. W. SALEEBY

THE title of our new course has a somewhat formidable appearance. It suggests physiology, but sounds even more obscure, and the very fact that it is spelt with a silent "p" is an annoyance. There is little doubt that a better word for the description of the science of mind would have been phrenology, *phren* being the Greek word for mind. But, as everyone knows, that term has been taken for the pseudo-science which attempted to discover the mental and moral characters of a man by observation of his skull. That curious delusion is abandoned, but we shall have to spend some time upon what may be called the new phrenology, which enables us to allot to certain well-marked areas of the brain the performance of certain mental functions.

What Psychology is not. Psychology is literally the science of the soul; but we cannot here employ a term to which many meanings have been applied, and we may content ourselves by defining our subject as the science of mind. Most emphatically we must reject a now popular modification of this definition, wherein we are asked to believe that psychology is the science of consciousness. If there is anything of which the unbiassed, open-eyed psychologist of to-day is convinced beyond all question, it is that there are realms of mind, of mental activity, of psychical processes—use what term you please—that lie beyond the sphere of consciousness. We do not like to say "below the level of consciousness," because that figure suggests inferiority, and these processes must be regarded as in many ways of far profounder significance than consciousness itself. Consciousness and mind are not synonymous; their realms are not coterminous. The latter has an immeasurably wider meaning than the former; so far, indeed, is consciousness from being the whole of mind, that it should rather be regarded, important though it be, as a mere aspect or function of the immeasurable reality which it is our business to study in this course.

Is It Worth While? Here and there, a sober and business-like reader may ask whether it is worth his while to pursue this subject. He fully understands the importance of matter and energy, of chemistry and physics, of engineering and electricity. To study these is to make some acquaintance with modern science, which is none other than organised knowledge, and which is, therefore, assuredly destined to rule the world. But is it worth while, he may ask, to study mind? Even supposing that men can discover anything about it, is the knowledge worth having? If such a reader will give us a fair hearing, we may convince him that it was worth his while. If we fail to do so, the fault will certainly be in our own incapacity, and not in the subject.

Or, there may be another reader with an exact and sceptical mind, loving accuracy and precision of statement, impatient of anything that cannot be closely measured, and still more impatient of speculation, or of anything that claims to be science, whereas it is no more than a mere word-spinning. Such a reader, rather exaggerating the facts, may ask whether the history of thought is not strewn with the wrecks of false psychological systems, and whether there is any certainty in the matter. But we hope to convince such a reader that modern psychology is a real science, employing the same methods and principles as any other science, and worthy of no less respect.

The Key to the Facts of Life. But we cannot yet proceed to our subject without insisting upon the transcendent importance which the advance of science has lately conferred upon it. The student of the course on PHYSICS will remember the references to the materialism of thirty years ago. He will remember that that doctrine is now no longer held, save by two or three unfortunates here and there, who have added nothing to their knowledge since 1870. In a subsequent course we shall have to discuss materialism and its modern equivalent. For the present, we must merely observe that since it is no longer possible to explain man and the universe in terms of matter and force, the study of mind, which is neither matter nor force, has assumed new importance, or, rather, has been restored in the eyes of all to the supreme place which it has held in the eyes of the wise since the dawn of thought. If we are convinced that matter does not hold within itself the key to the riddle of existence, and if we hold that there is any key to the riddle, it is to mind and to mind alone that we must turn. The study of philosophy thus necessarily demands a prior study of psychology, and since philosophy is no less than the quest for reality, this ground is plainly the highest upon which we can place the claims of our study.

But from other than the philosophical points of view, psychology is equally important. For instance, we have to recognise that the behaviour of men, that human nature, accounts for an enormous proportion of the evils of life, and also that it is the key to an overwhelming proportion of the facts of life. The key to all human institutions is human nature. The study of man as a social animal, the study of his history, his laws, the rise and fall of nations, of civilisation, of the types of societies, of

marriage, of progress and decadence wherever found—the due study of all these, nowadays subsumed under the science of Sociology—demands an acquaintance with the science of man's mind.

But these are not practical matters, it may be said; yet the effects of legislation and the due construction of laws are practical matters, and so is education, which, indeed, properly regarded, is of higher practical importance than any other matter. Yet there can be no due education, no real comprehension of the problems involved, no adequate solution of them, without an understanding of the manner in which the human mind is developed from infancy to adult life. If psychology could justify itself to the utilitarian on no other score than its importance in education, it would have a justification surpassable by that of no other science.

The Methods of Psychology. The mind, of course, is the instrument of all the sciences, psychology included, and thus the science of mind is in the extraordinary and unique case that its instrument and its subject are one. Thus there are two distinct ways of studying our subject—ways to which there is no parallel in the case of any other science. We may look within ourselves and study our own minds—the method of *introspection;* or we may look out at other minds than our own, just as we look at a mineral or a meteor, but with this profound difference—that we make the acquaintance of other minds than our own by the intervention of matter. The only mind which each of us knows at first hand is his own; the fact that there are any other minds than his own is really no more than an inference from the physical actions of other persons. He might, if he chose to be so foolish, regard other persons as merely automatic, which was the preposterous verdict of the philosopher Des Cartes upon the lower animals. Thus it is open to each of us either to study his own mind immediately, or to study the minds of others mediately—the medium always being matter of one kind or another. The contrast between these two methods may be made at this very early stage of our study, because it helps us to understand its history; and having defined our subject, it is, of course, most desirable that we should proceed to a brief account of its history, which is one of the most remarkable and instructive of its kind.

"Know Thyself." From the remote ages of the earliest Greek philosophy, the Ionian speculation of more than five centuries before Christ, comes the ancient maxim, "Know thyself," the wisdom of which has remained to this day as the shortest and final verdict on the value of psychology. If we roughly review the whole of Greek philosophy, we find the study of mind to have occupied far more time and attention than, perhaps, all other subjects taken together. The results, however, are utterly disproportionate. This is said without bias, no one having a more profound respect for the incomparable Greek genius than the present writer. But it is the fact that scarcely any psychological truths whatever are yielded us by the sum total of Greek thinking on this subject. On the other hand, there is an enormous mass of error, the greater part of which is not merely erroneous, but ludicrous and ridiculous.

Now, how are we to explain this fact, remembering how great and sincere were the thinkers who accomplished so little? Probably the chief explanation is that these thinkers were absolutely without any appreciation of the scientific method. They made no experiments, they made no systematic observations. Both experiment and observation they despised as partaking of the mechanical or as diverting the mind from the contemplation of the "pure idea." They confined themselves to the introspective method alone; and the whole history of psychology through more than twenty-five centuries teaches with uniform monotony that the introspective method alone invariably and signally fails.

The Slow Progress of Psychology. The second most conspicuous reason for the failure of the Greeks and for the amazingly slow progress of psychology until the nineteenth century is to be found in the fact that the science was not clearly distinguished from the other studies with which it is allied, or, rather, upon which it has a bearing. When we consider the subject of heat in the study of physics [see PHYSICS] we see how absolutely essential it is to distinguish between the physical and psychological aspects of our inquiry. We see, for instance, that we should err most grievously if we were to estimate heat by our sensations. In the first place, there is no trick that our sensations may not play us; and in the second place, the character of our sensations does not depend alone upon the character of the external objects which arouse them, but upon the character of those objects *and* upon the character of our senses; the second factor being, indeed, of incalculably more importance than the first. For centuries and centuries the progress of physics, and, indeed, of all the sciences, was hampered, if not almost entirely arrested, by the backwardness of psychology, and there was thus established a vicious circle. For psychology itself could not advance until the value of the scientific method had been demonstrated in the other sciences.

But, on the other hand, psychology was injured far more seriously by its confusion with metaphysics and countless false philosophies and religions. At last psychology has freed itself, in almost every civilised country except Great Britain, from all its encumbrances, and is pursued as a free and independent science—that is to say, free and independent as the other sciences are, free from external dictation. But, as in all history at all times, there has been reaction and falling into extremes; and this we shall illustrate in a moment, after we have briefly alluded to the great names in psychology between the decadence of Greece and the middle of the nineteenth century.

Great Names in Psychology. Greece was succeeded by Rome, the greatest military power the world has ever seen; but Rome

added scarcely anything of moment to art, certainly nothing original, and even less to science and philosophy. Then came the dark ages, during which the scanty seeds of knowledge were tended by an Arabian thinker here and there. In the thirteenth century the greatest philosopher of the church, St. Thomas Aquinas, reinstated, by the force of his genius and skill, the philosophy of Aristotle, whom we may call the last and the greatest of the Greeks, and whose work, or such of it as had been preserved at all, had been flouted for more than forty generations. Aquinas went as far as the available science of his time—a pitiable quantity—could possibly take him. His psychological views are now merely of historical interest. Nor was psychology appreciably furthered by Des Cartes (1596–1650), or Spinoza (1632–1677). To the former, however, it appears that we must attribute, at any rate, the germ of a very great discovery, the discovery of what we call *reflex action*. Spinoza did little for psychology proper, but, as we shall see in a subsequent course, performed a lasting service for humanity by his study of the relations between psychology and the ultimate problem of philosophy.

Are We Born with Ideas? The next name that demands mention is that of the Englishman Thomas Hobbes (1588–1679), who was born before both Des Cartes and Spinoza, but outlived them both. In a review of our subject so brief that an immortal like Spinoza is dismissed in a phrase we can say no more of Hobbes than that to him must be credited the first clear recognition of the psychological law of the association of ideas.

Greater—as a psychologist, at any rate—than the author of the "Leviathan" is his succcessor John Locke, of Oxford (1632–1704), whose great "Essay concerning Human Understanding," one of the epoch-making books of all time, was published in 1690. The greatest accomplishment of Locke's great life-work was his destruction, once and for all, of the belief in *innate ideas*, with which psychology had handicapped itself until his time. All our knowledge whatsoever, he declared, is derived by "sensation," and by "reflection" upon the ideas derived by sensation. In other words, he declared that the whole of our knowledge is the product of experience. As an example of the more comical aspect of the notions which Locke refuted, we may quote the old belief that if a child were left to grow up without hearing any language he would revert to the supposed practice of his first parents, and speak Hebrew ; on the contrary, we now know that the child would be an idiot.

Thus, the doctrine—not wholly true but very nearly so—which every one associates with the name of Locke, is a denial of the notion that the human mind is possessed of any innate ideas. He set himself to prove that "nothing is in the mind that was not first in the senses" (*Nihil est in intellectu quod non prius fuerit in sensu*). The child's mind, he declared, must be likened to a *tabula rasa*, a clean or blank tablet, on which nothing has been written. Aristotle had this idea, but did not avail himself of it. Thus, for Locke, all mental products whatever result from sensation, and from reflection upon past sensory experiences.

Immanuel Kant. Locke's great successor was the German-Scot Immanuel Kant (1724–1804). He is the dominant mind of the century which elapsed between Locke's death and his own. Now, Kant agreed that we cannot hold any ideas to be innate ; he declared, however, that *time* and *space* are not ideas, but forms of the mind ; not *thoughts*, but *apparatus for thinking*. As regards space, the doctrine of Kant is now definitely disproved. Modern psychology can describe with practical completeness the mechanism by which our ideas of space are built up ; while it has gone far to explain the idea of time, for most certainly it regards both space and time as *ideas*, Kant notwithstanding. In a sense it is, of course, true that time furnishes one of the forms in which we think. Are we, then, to believe Locke, and try to conceive the idea of time as imprinted afresh upon each new mind—each such mind being as little predisposed to this or any other idea as is a blank sheet of paper ? Or are we, with Kant, in some mystic manner, to conceive of time as an idea or form of thought which is native to mind and owes nothing to the external world—as a form, indeed, which mind, being somehow possessed of it, actually imposes, by its own arbitrary will, upon the outer world ?

As in a thousand instances before, the truth has been found somewhere between the two opposing extremes: Locke and Kant are both right and wrong. The nineteenth century produced a thinker to whom occurred the novel method of studying mind not as existing but as evolving ; and thus the work of the earlier thinkers was brought to fruition.

Mind and the Senses. The mind, of course, is not a *tabula rasa ;* never was less accurate a phrase. It has, in each case, its own ineradicable predispositions and prejudices—products of "æonian evolution." Amongst its predispositions may be reckoned a habit of looking at things under the form of time. So far the verdict goes with Kant and against Locke. But if we trace the history of mind, the almost incredibly base degrees by which it did ascend, and consider the amœba, or, indeed, the single microscopic cell which may become a Newton or a Wagner, we shall be hard put to it to detect any innate ideas or forms of thought therein. Locke was unquestionably right in upholding the doctrine that nothing is in the mind that was not derived by the senses. If, however, we conceive of sensory experience as producing changes in the percipient organs, and of such changes as being inherited, then we can understand how age-long ancestral experience of a Cosmos which has certain characters has gradually developed a form of nervous structure which fits every new inheritor of it readily to appreciate the outer world under the forms which the characters of that outer world have imposed upon nervous structure in the past. "Time and space" are *not* forms imposed on the outer world by

mind ; they are forms imposed on mind by the outer world.

Herbert Spencer. The thinker who has helped to solve the problem is Herbert Spencer, who died almost exactly a century after Kant and two centuries after Locke. His great contribution to the subject, called the "Principles of Psychology," demonstrates the evolution of the mind, and was published in 1855, four years before Darwin demonstrated, in the "Origin of Species," the evolution of the body. Spencer is thus the founder of the evolutionary psychology, by far the most philosophically important aspect of this science. The Scotsman, Alexander Bain, was a pioneer of the very important part of psychology which now has the uncouth name "physiological psychology." This is the branch of psychology which does not concern itself with origins, nor with philosophical questions, but attempts to associate as many mental processes as possible with physical or physiological processes. Very often this part of the subject, which has made the most astonishing progress within the last thirty years, is described as "experimental psychology"—the name given to it by its most distinguished exponent, Wilhelm Wundt, of Leipsic, who is, beyond all question, the greatest psychologist living when these words are written.

"Psycho - Physics." The astonishing progress of experimental psychology and of the physiology of the brain—very often called neurology, especially when it is contrasted with the almost stationary character of psychology through the ages which preceded it—has caused psychology to pass through a dogmatic period, closely corresponding to the dogmatic materialism from which physics has lately emerged. There was founded, for instance, the new "psycho-physics," which professed to be as accurate as physics itself and to calculate psychical processes in physical terms. It would be untrue to say that that science has accomplished nothing ; but it was based on a false assumption, and has not accomplished, nor will it ever accomplish, any but an infinitesimal part of what its founders expected. The attempt to do without introspection altogether, and to treat mind as if it were a material fact of physics, has proved to be as inadequate as was the introspective method alone. Only by a due combination of the two methods, despising neither the material facts of the brain on the one hand nor the immaterial records of consciousness on the other, can we expect to make real progress. Herein is a lesson for dogmatists of all parties.

Kinds of Mind. But there are some points on which we can and must dogmatise ; and one of them is this—the capital discovery, perhaps, of modern psychology—that it is no longer wise or defensible to conceive of mind as if it were possible to discover all its facts from the observation of one mind. From Plato to Kant, philosophers were content to look within themselves, and imagine that the facts they saw there were universally true. Psychology was purely introspective, and so it did not occur to its students to look out upon and contemplate minds other than their own.

It is true that one has direct knowledge of one's own mind, and only indirect knowledge of other minds. But that is no reason for proceeding on the ludicrously false assumption that it is possible to understand mind by the observation of single examples of it. Nowadays we have the psychology of crowds, the psychology of peoples, social psychology, child psychology, savage psychology, and comparative psychology, which studies the mental characters of the lower animals. It is an amazing thing that until the other day, so to speak, the very possibility of these subjects was scarcely conceived and was certainly not appreciated. At any rate, we shall no longer make such an error. We shall clearly recognise that psychology is at least—it may be more—an objective science, the student of which studies objects, things, existences outside him, which are none the less real because they cannot be seen or weighed like so many minerals, but yet which have to be studied in all their variety just as minerals are studied by the chemist and the geologist. Yet while we remember this necessary business of psychology, we shall not forget its unique character, in virtue of which the means of study—the mind—and the object of study are at bottom one and the same.

Is the Mind in the Brain ? And this introduces us at once to the fundamental problem of psychology, a problem to which we must return in the course on Philosophy. What is the relation of mind and body ? This question may be put in a rather striking form, offering a puzzle which, so long as it is put in that form, is utterly insoluble : Is the mind in the brain or the brain in the mind ? It is to be feared that an overwhelming number of those who have some acquaintance with the physiology of the brain are nowadays inclined to answer that the mind is in the brain. They would go on to say, perhaps, that the mind is not a thing, but a function—a function of the brain. Some, at any rate, would say this ; but many more would say that the mind must be regarded as a form of energy, the business of the brain being to convert other forms of energy—such as heat, chemical energy, and so on—into mind energy.

Is the Brain in the Mind ? On the other hand, a very much smaller number of persons, whose training has been of a different kind, will answer most positively that the brain is in the mind ; in other words, that all material things—the stars and the earth, the body and the brain itself—exist only in the mind, or in virtue of the mind which perceives them ! We have no space to spare at present for this extremely important doctrine, which demands our profound respect, even though it may raise a hearty laugh when first we hear it. It is a problem of philosophy rather than of psychology. But we must, at all costs, spare space for considering the very popular doctrine that mind is a form of energy.

Continued

A SHORT DICTIONARY OF PHILOSOPHY & PSYCHOLOGY

See also A Short Dictionary of Biology, page 32

ABERRATION—A departure from normal soundness of mind.
Abnormal—Deviating from standard type.
Absolute—That which is not relative.
Abstract—That which is considered as having no application to any particular object, or to other ideas which naturally accompany it; opposed to concrete.
Accident—That which is not essential or substantial.
Acquired—That which is not inborn.
Actual—That which is in reality.
Adaptation—Adjustment or fitness.
Aesthesia—Sensibility; the general power or process of feeling.
Aesthetic—Relating to the feelings, especially those of beauty.
Affection—The elementary form of feeling; pertaining to feeling of all sorts.
Affirmation—The mental process of establishing a connection between ideas. Thus, the affirmation "Snow is white," establishes the connection of snow and whiteness.
Aggregate—A general idea of a group taken collectively.
Agnostic—One who maintains a neutral attitude regarding all subjects which are incapable of scientific proof.
Agnosticism—The doctrines of the agnostics.
Alter—The individual's thought of another self as such.
Altruism—Dispositions having as their conscious end the advantage of an Alter or other self.
Amnesia—Loss of memory.
Analysis—That investigation which proceeds by a resolution of the complex phenomena of mind into simple ingredients or constituent factors. The analysis of a mental product is the viewing of it by separate acts of attention in its several component elements or aspects. This must be carefully distinguished from that actual separation of parts as seen in a chemical analysis.
Animism—The belief in the existence of a human spirit surviving the death of the body.
Annihilation—The reduction of the object into absolute nothingness.
Anoia—Want of understanding.
Antithesis—Logical or verbal opposition.
Apathy—Lack of normal emotional sensibility.
Apodictic—Capable of clear demonstration.
Apparition—An unusual or preternatural appearance or phenomenon.
Apperception—The fixing of a new sensation through the revival of kindred ideational elements.
Apprehension—The conceiving of a particular idea, object, or event, alone and apart from others.
Arcana—Things hidden or unknown.
Aristotle—A celebrated Greek philosopher, a disciple of Plato, born about 384 B.C.
Atheism—The disbelief of the existence of a God or supreme intelligent Being.
Attention—The special direction of the energy of the mind towards something present to it.
Attribute—An essential characteristic of a being or thing.
Auditory perception—Perception by hearing.
Aura—A supposed emanation of a psychic nature. Also the sensations that precede an attack of epilepsy.
Automatic actions—Actions effected by the living organism independently of any stimulus from without, or of volition.
Axioms—Necessary and self-evident truths.

BEAUTY—That which arouses a pleasing sensation, which pleases. Beauty is chiefly appreciated by sight and hearing.
Belief—A mental state in which judgment yields assent.
Bilocation—The alleged perfect and simultaneous existence of one and the same individual in two distinct places at one time.
Biogenesis—That view of the origin of life which teaches that living organisms can spring only from living parents.
Biogenetic—Pertaining to biogenesis.
Blind spot—That portion of the eye which does not transmit rays for perception.
Brain—The organ of the mind.

CAPACITY—The power of receiving or acting upon impressions.
Casual—Accidental, fortuitous.
Categorical judgment—A statement made as holding good without reference to any other condition.
Cause—That which results in existence.
Certainty—The degree of assurance felt with reference to something presented to the mind.
Characteristic—A distinct trait or quality.
Chiromancy—The art and science of attempting to interpret by the lines of the hand; palmistry.
Choice—The selection from competing means to an end.
Clairaudience—The alleged ability to hear sounds not normally audible.
Clairvoyance—The alleged faculty of seeing objects not normally visible to an ordinary observer under the same circumstances.
Co-adaptation—Complex, as opposed to simple adaptation.
Cognition—The being aware of an object.
Colligation—The union of quantitatively like elements in consciousness.
Complex—Not simple.
Comprehension—Knowledge of the relational type.
Conceptualism—The assertion that the mind has the power of forming general ideas, or ideas of classes of things, over and above the power of picturing individual objects.
Concrete—Objective, not merely abstract.
Condition—An essential thing.
Confucius—A Chinese philosopher (551–478 B.C.).
Congruity—The quality of agreement among the parts of an essential whole.
Conscience—Moral reason, moral sense.
Consciousness—In its widest sense, all modes of mental life; the sum total of psychical existence; the mind's knowledge of its own operations or of something acting upon it; the distinctive character of mental life.
Consent—The volition to allow something to take place.
Content—That which is mentally perceived.
Control—Voluntary command of mind or body. Used by Spiritualists to denote the influence believed by them to be exerted upon a medium by incarnate beings.
Co-ordination—The relation between constituent members of the same group.
Correlation—The act of apperception considered as resulting in explicit relationships of a mental whole.
Cosmology—A part of metaphysics; or a theory of the Cosmos.
Criterion—A standard of judgment.
Crystal vision—The awakening of visual sensations or perceptions by looking intently upon a crystal or polished surface.

DEDUCTIVE—The method of drawing inferences from the general to the particular.
Delusion—A false belief.
Design—A conscious and deliberate plan of action.
Desire—A craving, a yearning, a feeling of want; the mental state of uneasiness awakened by the representation of an absent good.
Determinism—The doctrine that denies the freedom of the will.
Discrimination—A judgment of differences between objects.
Docetian—Pertaining to the Docetæ, a sect which taught that Christ during his earthly life possessed a phantom, not a real body; that He acted and suffered only in appearance.
Dream—A mental and conscious though disordered process taking place during sleep.

EGO—The whole person; self. The personal identity.
Emotion—The faculty of feeling: passion, affection, sentiment.
Empiricism—The theory that accentuates the assumption that all our mental possessions are a product of purely sensuous experience.
Eudaemonism—The theory that happiness is the chief good for man.

FACULTY—That which renders a mental process possible.
Fatalism—The doctrine which teaches that all our acts are determined by fate or external circumstances, independently of volition. Never to be confused with determinism.
Free-will—The doctrine that we have freedom of choice in action.

GENERALISATION—The process of recognising likenesses, and asserting many particular facts in one general statement.

HABIT—A mental process whose repeated performance results in progressively easier accommodation.
Hallucination—The perceptual construction of an object having no elements of external reality. [Contrast Illusion, in which there are real data.]
Hypnosis—An artificially-produced sleep-like condition.

IDEA—A mental conception.
Idealism—The belief that matter has no existence other than as a sum of sensations—its *being* is *being perceived.*
Idealists—Those who deny the existence of a material world, independent of the mind of man or the Deity. The doctrine has many variants. [See *realism.*]
Identity—The recognition of a thing as different from all others.
Illusion—The construction from the basis of real data of a mental object incorrectly accepted as real. A deceptive act of apprehension.
Image—The mental scheme in which sensations are revived.
Imagination—The power of having mental images.
Immortality—That attribute in virtue of which a being is free from death.
Individual—A single being.
Inference—That operation by which we derive a new judgment from some other judgment previously known.

Instinct—A natural aptitude which guides animals in the unreflecting performance of complex acts useful for the preservation of the individual or the species; compound reflex action.

Introspection—Attention on the part of an individual to his own mental state.

Irrelevant—Not pertinent to the question.

JUDGMENT—The full, explicit carrying out of a process of synthesis.

KANT—A German philosopher, born 1724, died 1804. The central point of his system is found in the proposition that before anything can be determined concerning the objects of cognition the faculty of cognition itself, and the sources of knowledge lying therein, must be subjected to a critical examination.

MATERIALISM—The doctrine which denies the existence of any spiritual substance, and holds that mind is mere matter, or a product of the material organisation; opposed to Idealism and Spiritualism.

Medium—A person supposed to be sensitive to control by incarnate spirits.

Memory—An ideational process of reproduction and recollection of prior experiences.

Metaphysical—Pertaining to metaphysics. Abstract.

Metaphysics—That science which seeks to trace all branches of human knowledge to their first principles in the constitution of human nature. The science of mind or intelligence. The word is applied to the science which studies things as they are, as well as things as they appear. Sometimes used as synonymous with psychology [q.v.]. Sometimes as synonymous with ontology [q.v.].

Metempsychosis—The transmigration of the soul or ego from one bodily form into another.

Mind, or Soul—The thinking principle; that by which we feel, know, and will, and by which the body is animated. [See *soul.*]

Motive—Whatever attracts the will; the apprehension of a desirable end.

NEGATION—The opposite of affirmation. The denial of a connection between ideas. Thus, "The snow is not perfectly white."

Nominalism—The assertion that the universal, or general, has no existence, or objective reality, other than as a name which is applicable indifferently to various objects which resemble one another in certain respects.

Noumena—Things in themselves, objects of pure thought apart from all elements of the senses. The reality underlying phenomena or appearances.

OBJECT—Whatever consciousness recognises.

Obsession—The supposed efforts of an evil spirit to influence a human being. Also a "fixed idea" in the insane.

Occult—That which is hidden or secret.

Ontology—The doctrine of being. That part of the science of metaphysics which seeks to investigate and explain the nature and essence of all things—their *ultimate reality.*

Orientation—Normal ability to recognise one's surroundings.

PERCEPTION—Objective knowledge, the apprehension of external reality.

Phantasm—An apparition of a person still living.

Phenomenon—Something seen or perceived. Literally an appearance.

Philomathic—Pertaining to the love of learning.

Philosophist—A lover of sophistry, a would-be philosopher.

Philosophy—Literally the love of wisdom (*philos*, love; *sophia*, wisdom). The search for wisdom. In modern usage *philosophy* may be defined as the universal science which aims at an explanation of all the phenomena of the universe by ultimate causes. It seeks to explain phenomena by inquiring into causes, reasons, powers, and laws. Applied to a particular sphere of knowledge, it denotes all the general principles relating to that sphere—*e.g.*, moral philosophy means the science which treats of duty.

Phrenology—Literally the science of the mind (*phren*, the mind; *logos*, discourse). The term now means a doctrine founded on an assumed knowledge of the functions of various parts of the brain obtained by comparing their forms and magnitudes in different individuals with the traits which these individuals are found to possess. The theory was first propounded by Gall, a Viennese physician. The faculties in this system are divided into two groups—feelings and intellect. A phrenological chart is a map of the head drawn on the skull which purports to indicate on the exterior the particular areas of feeling or intellect which lie in the brain underneath.

Planchette—An apparatus for recording delicate movements of the hand, and by which so-called automatic or spirit writing is obtained.

Platonic—Pertaining to Plato, or his philosophy.

Platonism—The ethics, physics and dialectics of Plato. It is maintained that there is no one system in these writings to which the author uniformly adheres.

Poltergeist—A supposititious incarnate being which, while remaining invisible, demonstrates by mischievous acts and noises, usually in or about houses.

Preternatural—Transcending ordinary natural agencies.

Psychiatry—The medical treatment of mental diseases.

Psychic, Psychical—Pertaining to the human soul or spirit or mind. Especially now applied to that force by means of which spiritualists aver they can communicate with the spirit world, also by which they can move material things without physical agencies. The force by means of which so-called spiritualistic phenomena are produced.

Psychology—That branch of philosophy which studies the human mind or soul, and consciousness wherever found, as in the lower animals.

Psychometry—The power supposed to be possessed by some persons of ascertaining from an article some characteristics of its possessor. A method of determining the interval between the reception of a sensory stimulus, and the execution of a responsive movement.

Psychoses—The manifestations of phenomena of mind.

Psycho-therapeutics—The treatment of morbid conditions by "suggestion" or hypnotism.

Purpose—A deliberately-formed intention with regard to a series of acts, or a remote end.

RAPPORT—The peculiar relationship which exists between a hypnotised person and the hypnotiser.

Rational Psychology—The investigation into the nature of the mind itself.

Realism—The doctrine that matter exists per se and apart from the subjective sensations of the percipient mind. Opposed to idealism [q.v.].

Reason—(1) The intellectual power of understanding; (2) the particular exercise of the understanding involved in the process of reasoning; (3) the total aggregate of spiritual power posseesd by man.

Reflex Action—Movement in response to sensory stimuli without the intervention of any mental effort.

Resolution—The mental determination of a purpose.

SCEPTICISM—Absolute scepticism is the theory that positive truth is unattainable by human intellect; partial scepticism discredits some convictions of mankind, generally deemed to be of vital importance.

Self—The subject of individual consciousness.

Self-consciousness—The process of reflection on the self.

Sense—The capacity of the living being for a particular species of sensation.

Sensibility—The power of experiencing sensation.

Sentiment—An emotion of an abstract character.

Socratic—Pertaining to Socrates, the Greek sage, or to his method of teaching and philosophy. That method was by means of interrogatories. The proposition was not laid down authoritatively, and the pupil was led to acknowledge it by a series of questions put to him. The inductive method and the definition of ideas are two principles of science ascribed to Socrates.

Soul—The mental principle believed by Animists to be separate from the body, and having personal individuality.

Spectre—A ghostly apparition.

Spinozism—The system of philosophy of Spinoza, born 1632, died 1677.

Spiritualism, or Spiritism—A form of animism which holds that the human identity persists after physical death, and that incarnate spirits can by means of a peculiar psychic force communicate in various ways with living human beings.

Sub-consciousness, sub-liminal consciousness—The conscious process given in a state of inattention; consciousness apart from the waking state.

Subjective—Denoting mental in opposition to material phenomena.

Syllogism—A type of deductive reasoning.

Synthesis—The process of integrating, or combining, thought.

TELEPATHY—Communication between mind and mind otherwise than through known channels of the senses.

ULTIMATE—The last of a series.

VOLITION—The act of determining choice, or forming a purpose.

Voluntary—Pertaining to the will; subject to, or controlled by, the will. Intentional. [See *reflex action.*]

WEREWOLF—A conception belonging to the superstition that human beings took the form of wolves, while retaining human intelligence.

Will—The capability of self-determination. Synonymous with volition.

ZOOTHEISM—The worship of Deity under the form of an animal.

Zoroaster—A teacher of Eastern Iran. Date unknown (probably about 1000 B.C.).

GOVERNORS AND FLYWHEELS

Types of Governors. Centrifugal Force in Machine Construction and its Requirements. Different Kinds of Flywheels. Hammers

By JOSEPH G. HORNER

IT seems a far cry from the devout Galileo watching the swinging of a lamp in the dim religious light of a church at Pisa to the mathematical theory of a governor!

Yet the factors that enter into calculations concerning governors are related to those with which the swinging of a pendulum are concerned. A few simple tests with a leaden ball attached to a fine thread suspended from a hook or nail will reveal one or two important relations between the length of thread and number and time of oscillations. If the arc through which the leaden ball swings be not very great, it will be noticed that with the same length of string the same time is occupied by each oscillation, although the angle through which the pendulum swings may vary. In other words, the oscillations through small arcs are isochronous (Greek *isos* = equal, *chronos* = time).

The Pendulum and the Governor. Careful observation would also show that as the thread is increased in length the time occupied by each swing increases, and that the number of oscillations in a given time decreases. With one thread 9 or 25 times as long as another, the time of each oscillation will be three or five times as long, and the number of oscillations reduced to $\frac{1}{3}$ or $\frac{1}{5}$. That is, in different pendulums, the duration of the oscillations varies as the square root of the length of the pendulum, and the number of oscillations in a given time varies inversely as the square root of the length. Several important relations are shown by the formula $t^2 : \pi^2 :: 1 : g$, where t is the time in seconds of one oscillation; π, the ratio between the circumference and diameter of a circle $= 3 \cdot 1416$; l, the length of pendulum; g, the acceleration due to gravity, 32·2 feet per second. Thus,

$$t^2 g = \pi^2 l,$$

and therefore time,

$$t = \pi \sqrt{\frac{l}{g}};$$

and acceleration of gravity,

$$g = \frac{\pi^2 l}{t^2}.$$

(This latter formula has been used for determining the value of the acceleration of gravity at different points in the earth's surface.)

The connection between the theory of the pendulum and that of the governor is more clearly seen in considering the action of a simple conical pendulum [216]. The ball G, suspended by the string GH, from the point H, describes a circle as shown by the dotted lines, outlining in its revolution the figure of a cone. Now, the forces which act on G are identical with those acting on the balls of an unloaded Watt governor, if we neglect the weight of the arms and sleeve.

The Operating Forces. These forces are three in number: A, the tension or pull of the string, as shown by the arrow, along GH, this being equivalent to the pull of the arm of a governor [217]; W, the weight of the ball acting downwards; F, the centrifugal force tending to move the mass outwards from the centre (see below). Here, then, we have a system of forces in equilibrium to which the triangle of forces may be applied [217]. Then, $F : W :: r : h$, r being the radius from the centre of the mass to the axis, and h the height of revolution. Therefore, $F \times h = W \times r$, and since, as stated below, centrifugal force

$$= \frac{W\pi^2 r n^2}{900g},$$

this value of F may be substituted in the equation:

$$\frac{W\pi^2 r n^2}{900g} \times h = W \times r$$

and

$$W\pi^2 r n^2 \times h = W \times r \times 900g.$$

Therefore,

$$h = \frac{W \times r \times 900g}{W\pi^2 r n^2} = \frac{900g}{\pi^2 n^2};$$

and since $900g \div \pi^2$ is a constant, it is clear that the height of revolution, h, does not depend on the weight of the ball or the length of the arm, but on the rate of revolution. As this increases, h must diminish, just as the shortening or lengthening of the rod of an ordinary pendulum affects the number of oscillations in a given time. As h diminishes, owing to the increased speed of the engine and consequent flying outwards of the balls, the sleeve is raised, and this, acting on the links and levers, partially closes the throttle valve, and so reduces the volume of the steam and speed of the engine, as described later.

If the number of revolutions per minute are known, the value of h may be found for this class of governor by the above equation ($\pi^2 = 9 \cdot 8696$; $900g = 28{,}980$). And since $n^2 = \frac{900g}{\pi^2 \times h}$, then the number of revolutions per minute

$$n = \frac{1}{\pi} \sqrt{\frac{900g}{h}}.$$

The Loaded Governor. In order to enable the governor to work at a higher speed and operate the throttle valve with greater delicacy and precision, the governor is loaded by a central weight, and the relations shown by the equations for an unloaded governor then become:

$$h = \frac{900g}{\pi^2 n^2}\left(\frac{W + w}{w}\right),$$

$$n = \frac{1}{\pi}\sqrt{\frac{900g}{h}\left(\frac{W + w}{w}\right)},$$

in which W is the weight in pounds of the central weight, and w that of each ball. On comparing these equations it is clear that for any particular height of revolution, the speed of revolution is greater in the loaded than in the unloaded type ; and that for any particular rate of revolution, the height, h, is less in the loaded form than in the other type. Also, the advantage in speed is represented by the ratio $\sqrt{W + w} : \sqrt{w}$. Friction has also to be considered, but both theoretical and practical demonstration show this to be a negligible quantity as $W + w$ is increased. Loading a governor either by a central weight or a spring thus provides a means of overcoming great frictional resistance.

Centrifugal Force. In considering the forces acting on the balls of a governor, allusion was made to centrifugal force, and, before proceeding further, it will be advisable to consider this force. Really the term centrifugal (Latin *centrum* = the centre, *fugio* = I fly from) is a misnomer bequeathed to us by early philosophers, who concluded that a force existed tending to drive bodies revolving in a circle away from the centre. Otherwise, they argued plausibly, how shall we explain the counterbalancing force necessary to compel a body to revolve in a circle as seen, for example, in the whirling round of a weight attached to a string. Hence, the term *centrifugal* force was used to indicate the tendency of the body to fly from the centre, and *centripetal* force to indicate the pull towards the centre, these forces being necessarily equal and, of course, opposite.

Actually, however, the tendency of such a body is to continue its motion in a straight line—*i.e.*, to obey Newton's first law, "Every body continues in a state of rest or of uniform motion in a straight line, except in so far as it is compelled to change that state by force acting on it." Therefore, at any point in the circle the body W [**218**] is forced to move in an unnatural path, and tends to move as a tangent to that circle, as at *a–b*, *c–d*, *e–f*. Remembering that the term acceleration may mean a change in *direction* as well as in velocity, the body W thus has an acceleration towards the centre of the circle, its amount being represented by $v^2 \div r$; v = velocity in feet per second, and r = the radius of the circle in feet. The centrifugal force is the product of this acceleration and the mass of the body, and since the latter

$$= \frac{\text{weight of body}}{g},$$

then
$$F = \frac{Wv^2}{gr},$$

in which F represents the magnitude of the centrifugal force and W the weight of the body in pounds. As velocity

$$= \frac{2\pi r \times n}{60}$$

($2\pi r$ being the circumference of the circle, and n the number of revolutions per minute), this quantity may be squared and substituted for v^2 in the formula, thereby giving another statement for centrifugal force when the number of revolutions per minute are known.

$$F = \frac{W\pi^2 r n^2}{900g}.$$

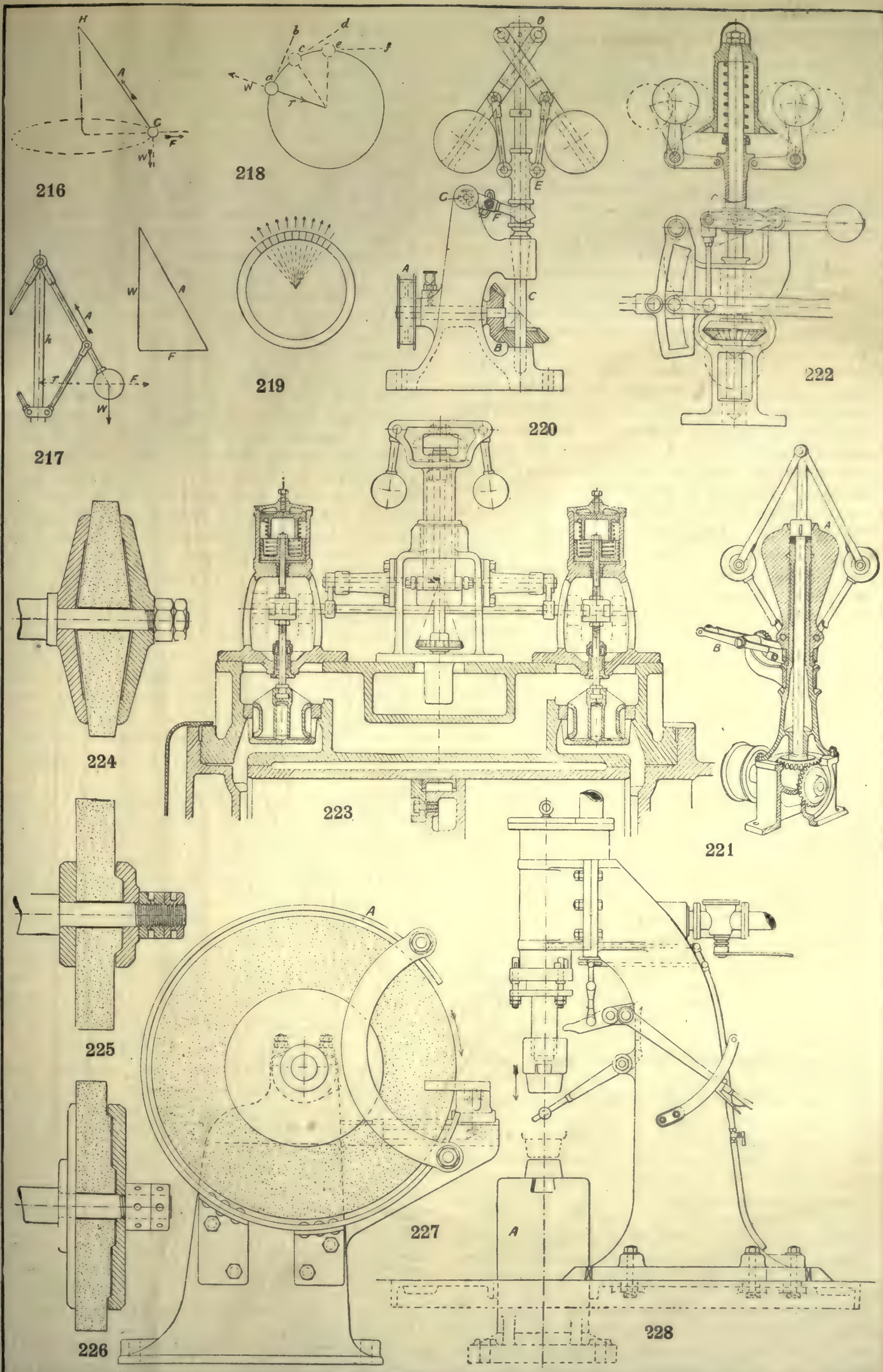
Wherever, in engineering, revolving masses are concerned, these centre forces have to be considered, and if there exist any lack of balance in the revolving parts, the wear on the bearings, and the vibration set up, will cause considerable damage.

Bursting of Flywheels. In the governor (which *regulates* the speed of an engine), centrifugal force is utilised in the opening out of the balls, but in the flywheel (which *steadies* the speed of an engine), and other revolving wheels, centrifugal force produces a tension in the rim sufficient at times to burst the wheel, sometimes causing loss of life. Consider the rim to be divided into a great number of small sections, as in **219**. The centrifugal force for each separate section is then equal to: weight of section $\times v^2 \div rg$. For the whole, the aggregate of all the sections, F = weight of the rim $\times v^2 \div rg$. The tensile stress, however, in the rim acting tangentially as in **218** amounts to

$$\frac{\text{weight of rim} \times v^2}{2\pi rg}.$$

The Purpose of Flywheels. The main purpose of the flywheel is to provide a reservoir of energy. In the steam engine, and also in gas and oil engines, the energy is supplied in jerks, as it were, at brief intervals, while the work to be done—the resistance to be overcome—is a constant quantity. This intermittent supply of energy is sometimes noticeable in steamers propelled by paddle-wheels as a monotonously regular forward jerk. But the enormous mass of a steamer, a locomotive, or a train is sufficient to store up the excess of energy during the period when the supply is greater than the demand, and to part with it when the resistance exceeds the power supplied. Hence, it is hardly necessary to say that a flywheel is not required in marine or locomotive engines. There is another case where a flywheel is needed—when the energy imparted is used periodically instead of regularly. Punching and shearing machines are an example of this intermittent utilisation of energy. The accumulated energy of the flywheel is sufficient to produce the operation of punching, shearing, slotting, etc., when without its aid the engine would possess insufficient power to perform these operations.

The Stored Energy of Flywheels. The energy acquired by the flywheel is called "kinetic energy." Work is performed by the flywheel in virtue of its *motion* just as the



GOVERNORS, EMERY-WHEELS AND HAMMERS

potential energy of a pile-driver enables it to perform work in virtue of its *position*. Work is done until the body possessing kinetic energy is brought to rest. The kinetic energy of a moving body of mass m

$$= \frac{m \times v^2}{2g},$$

and in the case of a wheel the velocity in feet per second

$$= \frac{2\pi r \times n}{60},$$

where n is the number of revolutions per minute. Therefore kinetic energy of flywheel

$$= \frac{m \times \left(\frac{2\pi r \times n}{60}\right)^2}{2g} = \frac{m \times 4\pi^2 r^2 \times n^2}{2g \times 3600} = \frac{m \times \pi^2 r^2 \times n^2}{2g \times 900}.$$

Inspection will show that for one particular flywheel all the quantities in this equation are constant except n. Hence the kinetic energy depends directly on the square of the number of revolutions in a minute, while for different wheels the energy is proportional to the mass and the square of the velocity.

Practical Issues. It must not be imagined that the design of an engine governor is so simple a matter as to be embodied in the formulæ just given. If such were the case, there would not be so large a number of variations in design. Many of these are veritable puzzles to the uninitiated. But if we consider for a moment or two what a governor is expected to do in the modern factory or generating station, we shall at least understand that the problems presented are not so easy of solution as they appear on first thoughts.

Conditions of Governing. The most exacting conditions are those that exist in cotton-spinning mills and in electric generating stations. A variation of about 2 per cent. in the number of revolutions per minute of a high-speed engine is as much as is consistent with steady, satisfactory working. Two per cent. is a very small margin when we remember that the governor cannot begin to act until the speed of the engine changes. Hence the necessity for responsiveness, a need which increases with speed. So that the difficulties of fitting governors instantly responsive are much more difficult of solution than they were in the old days of slow-running engines, for which the Watt governor answered well enough. A very brief account of some of the principal devices is all that can be given here, bearing in mind that however diverse the forms, the principle remains unaffected—that is, the centrifugal force and gravity must be in equilibrium. It is necessary also to mention that improvements are not wholly to be credited to the governors alone, but also to better forms of throttle-valves, as those of double-beat type, which are more delicate and precise in action than the old elliptical throttle-valve.

Crossed-arm Governors. The early type of Watt governor is shown in **217**, where h is the height of the cone, measured from the radius line r to the apex. This governor is too sensitive, because the height h varies greatly and rapidly with changes of speed. As the number of revolutions per second varies inversely as the square root of h, it is not possible for the engine to run regularly. A better form is that in which two points of suspension are provided at some distance below the apex, because as the balls rise, the apex drops, and therefore there is less effect on the height of h than in the previous case, and the balls have to move a less distance to effect a change in speed. The best form possible in this design is the crossed-arm governor [**220**], where h remains nearly constant for all variations in load. This is approximately isochronous, or astatic, a condition which is best fulfilled when the balls move in a parabolic path, and these do so nearly. But it is not a perfect governor, because it is liable to *hunt*, due to its sensitiveness. That is to say, it is too quickly responsive to minute changes, with the result that it will sometimes produce, instead of check, changes. Hence, pseudo-astatic governors, or those in which the too rapid action is checked by springs or weights, are preferred. Moreover, one essential condition to responsiveness is that the governor shall run more rapidly than the engines, so that with the high-speed engines of to-day the speeds of governors have to be very high. Some contrasts are shown by the figures.

Fig. **220** is a good pattern of crossed-arm governor, approximately astatic. It is driven by the small belt pulley A through bevel wheels B to the spindle C, carrying the crosshead D, from which the arms are suspended. The sliding sleeve E receives the connecting rods by which the vertical movements of the arms are transmitted to the lever F, the spindle G of which actuates the throttle valve in any convenient way.

Centre-weighted Governors. A much better type is the centre-weighted, or Porter, governor [**221**], made also with many variations in the details of fitting. Here—the example being by Tangyes, Ltd.—the balls are connected to rods above and below, forked to embrace the top of the vertical spindle, and the lower portion of the central weight A. As they fly outwards, therefore, they raise the weight, but their movement is also checked by its resistance. The throttle lever B is actuated as before, through a forked end, and the governor is belt driven also by the pulley and bevel gears seen below.

Spring Governors. In another large group of governors the resistance of a spring is utilised to check the opening of the balls. In these the resemblance to the Watt is not obvious. There are many, as the Hartnell [**222**], Burrell, Robey [**223**], and others. The power of the spring is adjustable. In **223** the governor controls the action of two sets of valves, as shown, with dashpots.

Slip is fatal to the accurate working of governors, hence the belt driving is often abandoned ; chain driving by a Renold chain sometimes takes its place, but more often the governor is put on the crank-shaft.

Many governors exercise direct control over the slide valves through the slot links, an illustration of which occurs in **222**.

Flywheels. These are dangerous objects unless the results of centrifugal force are safeguarded in some way. Many flywheels have fractured, with results disastrous to property and fatal to life. The following are the methods adopted in modern practice.

Cast-iron Flywheels. In casting these, the first difficulty lies in the shrinkage of the metal in unequal sections. Thus, the rim alone is considered in apportioning the mass of revolving metal, the arms being neglected, as far as their mass is concerned. Their only function is the due connection of the rim with the boss, and this is a point of cardinal importance—the embodiment of sufficient strength to resist the pulling or tensile action of the rim, and to resist the effect of stresses set up by the shrinkage of the cooling metal. The latter alone has been the primary cause of many fractures of wheels, although the strength of the arms, as obtained by calculation, was ample.

Causes of Ruptured Flywheels. When a flywheel cools after casting, the rim and central boss remain hot much longer than the arms, and so continue to shrink after the arms have set rigidly. This is where the mischief occurs. The shrinking rim and boss subject the arms to mixed stresses, and the arms resist the shrinkage of the rim and boss. The net result is that though the wheel does not fracture at the time of cooling, yet it is in such a condition of internal stress or tension, that a slight excess of speed of revolution above the normal is liable to fracture it. It is a fact that the majority of flywheel fractures arise from this cause alone. Much can be done by care on the part of the designer and founder to proportion the rim, arms, and boss; or by hastening the cooling of the rim and boss, and delaying that of the arms, so that the cooling shall take place in about equal times. This is properly done in cast-iron flywheels; but as there is always an element of risk, the practice has grown of abandoning such wheels in favour of those built up in separate pieces, bolted together, and in another direction of using arms of wrought iron in rims and bosses cast around the ends of the arms.

Though, therefore, cast iron is used for wheels of small and moderate dimensions, the composite wheels are almost invariably used for those of large dimensions.

Wheels with Wrought-iron Arms. In these the arms are cut off from the bar, jagged at the ends, and inserted in the mould with the jagged ends projecting into the spaces prepared for rim and boss, and the metal is poured round the ends, so enclosing them. There are two objections to this, one being the flimsy, skeleton-like, unsightly appearance of the arms; and secondly, the real risk of the arms becoming bent by the centrifugal efforts of the rim, an accident which has frequently happened. Hence the reason why the built-up wheels have preference.

Built-up Composite Wheels. Of these there are several designs, the best of which are found in mill engines, often combined with toothed wheels. Various means of union are adopted. The rim is cast in segments, and united with cottared dowels. The arms are cast individually, and bolted to the rim across the joints of the latter, and also bolted to a central boss. Or sometimes the boss segments are cast with the arms, and bonded with wrought-iron rings to maintain them truly.

Grinding Wheels. Revolving masses are continually exercising the ingenuity of the mechanic. The modern practice of grinding as a rival to purely cutting operations has given an immense impetus to the development of the use of rapidly rotating wheels of emery, corundum, carborundum, etc. Comparisons with the old-fashioned grindstone crawling slowly round at about 100 revolutions per minute gives no manner of idea of the emery wheels of to-day. The latter run at a peripheral speed of about 5,000 ft. per minute, and this subjects them to a tensile stress tending to burst them of about 75 lb. per square inch. Of course, such wheels do sometimes fracture, but evil results rarely follow, because provision is made with a view to prevent the fragments from flying asunder. This takes two forms. In one [**224, 225,** and **226**] the body of the wheel is so gripped by bosses that, even though it breaks, the pieces are still retained. In the other [**227**] a hood (A) encircles the wheel, excepting just at the locality where the actual grinding is being done, and so confines fractured portions.

Centrifugal force has to be carefully considered in connection with the armature windings of dynamos and motors. If these are not secured efficiently with bonds, the wires will fly outwards, and so work loose.

High-speed Shafts. A dynamical effect of much practical importance arises out of the rotation of unbalanced shafts, particularly that of crank shafts. The counterbalance weights put in the driving wheels of locomotives are carefully calculated and located to neutralise the dynamical effect of the two cranks, which are situated at right angles to each other, and by which the driving wheels are rotated through pistons and connecting-rods. They do for the crankshaft what the flywheel does for the ordinary steam engine. But for these cranks the motion of the engine would produce a succession of hammer-like blows on the rails, destructive alike to the rails and the mechanism of the engines.

The cranks of compound marine engines are balanced, but in a different way. Extensions are forged on the cranks at the side opposite to the crank.

When there are three cranks situated at angles of 120°, no counterbalancing is necessary, because the cranks balance each other round the axis.

Precautions with High-speed Pulleys. Plain shafts and pulleys, having no sensible lopsidedness, often develop wobbling or vibratory movement at high speeds. In the case of pulleys this is obviated, at the speeds at which they generally run, by balancing them in the course of manufacture on knife edges, and carefully removing metal from those portions which come to rest in the lowermost positions. This is

necessary in all high-speed pulleys. But shafts, though turned truly, do at a very high speed—the *critical speed*—develop vibration which often subsides at a higher or lower speed. In such cases extra bearing support must be afforded, or the shafts must be stiffened without increasing their weight. This explains, too, why stiffness in a shaft is of greater importance than mere torsional strength. The latter alone would yield impracticable results. It also explains why steel has superseded iron for shafting in present-day design.

Pulleys and drums of great weight on light shafts inevitably set up vibrations, in spite of good balancing; hence it is necessary to lighten them where possible. In present practice, pulleys of rolled steel have largely superseded the heavier ones of cast iron; and those built of timber, lighter than steel, enjoy a rapidly growing popularity.

Hammers. Of the gravity mechanisms pure and simple, perhaps the most obvious are the pile-driving monkeys, and the steam and drop hammers. Here foot-pounds = lb. weight multiplied into the height fallen in feet, represents the dynamical effort. In either case the monkey, or the tup, is the weight usually taken as the falling weight, though in steam-hammers [**228**] the weight of the piston and piston-rod should be included. An advantage of all these mechanisms is that one of the factors is capable of variation, that of the height of fall. In the pile-driver, the winch by which the monkey is raised regulates it; in the steam-hammer it is the volume of steam admitted; in the drop-hammer the height is regulated by the belt or board.

Although we have spoken of the falling weight of a hammer only, few steam-hammers are made like this now, but the pressure of steam is introduced to accelerate the descent of the tup. This increases the speed of working, enabling many more blows to be struck in a given time, in addition to the greater dynamic effect. Hammers are made generally to operate by working a hand-lever for each blow, or self-acting, as in the type shown in **228**. Note should be made of the great relative mass of the anvil-block A, of cast iron, which is absolutely necessary to enable it to absorb the blows without excessive vibration.

The Hammer Blow. The energy of the blow of a hammer is expressed in foot-pounds, and may be ascertained by the following formula:

a = Area of piston in square inches.
p = Average pressure of steam on piston during downward stroke in pounds per square inch.
S = Stroke of piston in feet.
W = Falling weight in pounds.
E = Energy of blow after full stroke, and before striking, in foot-pounds.

$$E = (ap + W)S.$$

The velocity of the tup the instant before striking may be calculated by the following formula:

P = Total pressure on piston = pa.
F = Total force causing downward acceleration = $P + W = pa + W$.
g = Acceleration due to gravity = 32·2.
V = Velocity after full stroke and before striking, in feet per second.

$$V^2 = \frac{2FgS}{W}.$$

The force of a blow cannot be stated in terms of weight at all, because the pressure of a weight is continuous, whereas the force of a blow is expended in a moment. Messrs. B. & S. Massey, the steam-hammer makers, have, however, ascertained by careful experiments that the maximum blow of a 5-cwt. double-acting steam-hammer, with moderate steam pressure, produces a crushing effect upon a piece of hot iron as great as that produced by a load of about 30 tons, and a $\frac{1}{2}$-cwt., double-acting steam-hammer, a crushing effect equal to that produced by a load of about $2\frac{1}{2}$ tons.

Applied Mechanics concluded

PIANOFORTE PRACTICE

Influence of the Different Schools. Sight Reading. Pianoforte Study in England. Examinations. Memorising, Teaching, and Performing

continued from p. 1892

By M. KENNEDY-FRASER

ALTHOUGH the pianoforte is a comparatively modern instrument, and had not yet ousted the harpsichord by the end of the eighteenth century, still, the keyboard music of the Elizabethan period (1600), when English harpsichord players and composers were the first in Europe, is adaptable to the modern instrument. The music of the French Couperin of a century later (1700) is a rich storehouse of dainty keyboard pieces, while his contemporaries, the Italian Scarlatti and the German Bach, are used at this day as pianoforte classics.

Grading our Teaching Material. In grading music, moreover, for *teaching* purposes we do not take it chronologically. On the contrary, we should start with the music that is easily understood at the present day, and gradually learn to appreciate the idiom of the more difficult, because more remote, classics. And here, again, it is wise to begin with the music of Clementi, who lived a century later (1800) than Couperin. Clementi's music helps to form good keyboard habits, lying easily as it does to the hand, and affording a rich supply of pleasant material for the practice of scale passages and broken chords and the like, and containing nothing eccentric. It is not, however, very exhilarating musically, and the young student must have this sort of fare interlarded with bits from the modern romantic school—Schumann's "Jugend Album," Tschaikowsky's "Jugend Album," Grieg's "Lyric Pieces," Jensen's "Wanderbilder," and the like. Easy duet playing should be begun as soon as possible, and if Mrs. Curwen's method be used for beginners—which can be highly recommended—the elementary duets in it will be found to open an easy door to the delightful world of "ensemble" playing. The study of the really great masters of pianoforte literature—Bach, Chopin, and Beethoven—must not be entered on too soon; Schumann's bigger works, his "Papillons," "Novelettes," "Fantasie-stücke," etc., should also be left to a fairly advanced stage. His music, on the whole—like that of Brahms—is not so well calculated to lead the player into good tone production as Chopin's, although there are some works that prove the exception—for special purposes.

Influence of Chopin. Chopin's influence on the player's technique is like that of Bellini's on the singer's. These both insensibly lead the student into the "bel canto" with its exquisite beauty of tone and phrasing. One may say that, as a rule, the student should study the beautiful before the characteristic.

Mendelssohn's "Songs without Words" are dainty little tone pictures suitable to lead up to more solid fare, and a useful graded edition of them is Germer's, where you will find them in the order of difficulty. Easy and graceful salon music, such as Durand's waltzes and Godard's, Schuloff's, and Chaminade's pieces, should not be neglected, especially in the pianist's early stages, as they are suggestive as to colouring, rhythm, etc. Neither should waltzes be tabooed, as they teach much in a simple way in the matter of good phrasing and good melody work, and, again, rhythmical feeling. An excellent introduction to Chopin's Nocturnes will be found in some of Field's; and the knowledge of the fact that the French Pole began his nocturne writing in imitation of the Irish pianist composer makes the comparative study of the two interesting.

Introduction to Study of Bach. The best introduction to Bach is Bach. Use his little preludes and his two-part and three-part "Inventions" sandwiched with the easy gavottes, etc., from the suites; but the study of Bach should be preceded by a good course of Scarlatti. As we have said, in the earlier stages use the lighter works of the classical school—some of Kuhlau's sonatinas can be recommended—but do not omit to couple these with short romantic pieces.

Beethoven stands as the dividing line between the purely classical and the ultra-romantic schools. The great classicists before him were Haydn and Mozart; the great romanticists after him were Schumann, Chopin, and Liszt. The latter almost completely changed the style of pianoforte playing, but they themselves were grounded in the older classical school. Liszt, the greatest pianist of the nineteenth century, was a direct pupil of Czerny, whose pupils we all are, in an indirect way, through the practice of his famous studies.

It is reported, by the way, that the master wrote these studies standing at a desk in his teaching-room, while his pupils played through what they had prepared for their lessons.

Guides to Teaching Material. As a guide to the choice of teaching material of all kinds, one should possess such a book as Eschmann-Dumur's "Guide du Jeune Pianiste," which is a catalogue of the entire repertoire of pianoforte pieces and studies graded from the earliest stages up to the virtuoso summit.

For the application of educational principles to the elementary teaching of music there is Mrs. Curwen's Teacher's Guide, in two grades, and for helps in teaching the elements of form and elucidating the emotional content one should consult such books as Carpé's "Phrasing" (Novello), Ridley Prentice's "The Musician" (a guide for pianoforte students in six grades), Knott's "Elements of Music," and Corder's "New Morley." If we buy our music (the

standard works) as far as possible in volumes, we may thus form a library. The classics are cheap. Mendelssohn's *complete* pianoforte works, for instance, can be had in a beautiful edition for 7s. 6d. A complete copy of Chopin's mazurkas, the very best edition—Bote and Bock—can be had for 2s., and so with all his works. Beethoven, Schubert, Schumann, can be had on like terms. But it is a mistake to buy *miniature* editions for *study*, as they are bad for the eyes, and hinder ease in playing.

Sight Reading. As we advance we must patiently work at sight reading. In the elementary stages we may use Kunz's "Canons" (five-finger exercises in all keys), which can be used later as material for the practice of transpositions. With a fellow enthusiast let us play four-hand arrangements, beginning with easy gavottes by Rameau, Sully, etc., and persevere till we can play the symphonies of Haydn, Mozart, Schubert, Beethoven, and Schumann.

Nothing is so good for sharpening our rhythmical sense, and for acquiring and keeping up the art of sight reading, as ensemble playing of any kind. We should play accompaniments to violinists and singers whenever we have the chance. Begin with easy things. The good accompanist is rare. Schumann said that accompanying was a test of the musician. Transposition, which has already been treated in the SELF-EDUCATOR [see page 1057], should be studied, and for practising material we might get "Warriner's Transposition." In addition to the sight reading of song accompaniments we should *study* the best of the art songs, and ask the co-operation of singers. Such songs should not be approached merely from the singer's point of view—pianists will learn much from them.

The Modern Composers. There yet remains to be mentioned the pianoforte music of the latter half of the nineteenth century—that of the German Brahms, of the Scottish-Norwegian Grieg, of the Bohemian Dvorak (whose original four-hand music, "Legenden" and "Slavonic Dances," is of great value), of the Russians, Rubinstein, Tschaikowsky, Glazounow, Arensky, Rachmaninoff, Blumenfeld, Scriabine, Liadoff, and others; and that of the Parisian School—Saint-Saens, César Franck, Claude Dubussy, Mozkowski, Chaminade, etc., of the Scottish-American Edward Macdowell, whose "American Wood Idylls," "Sea Pieces," "Indian Idylls," and the like, are charming tone sketches of a light nature. The British composers since Sterndale Bennett, whose "Lake," "Millstream," and "Fountain" are alike poetic and pianistic, although they have occasionally written for the piano, have yet occupied themselves chiefly with cantatas, operas, and orchestral work, although mention must be made of Sir Alexander McKenzie's fine pianoforte concerto, the "Scottish," a work of really high rank. The younger British composers are, however, writing extensively for the piano, and among them there is not only great promise for the immediate future, but already brilliant achievement. Perhaps the new "*Edition Chas. Avison*" will do for these what "Belaieff" has done in the past for the Russian school.

Teaching. A few words now about teachers and teaching. Much is required from the pianoforte teacher. He is expected to teach alike literature and public speaking, as it were; he not only reads the classics with us, but trains us as dramatic reciters. Some teachers are strong on one side, some on the other, and some few are famed for both. Some try to make of the pupil a sound musician, some specialise in training for brilliance, some try to give technique, some interpretation. The art of tone production, or touch, till recent times, was left largely to chance. The most far-famed teacher in Europe for the last twenty years has been the Pole Leschititzky, in Vienna. He is an old man and much in request; it is not easy to get lessons from him; but he has a great number of "preparers" who work with him, giving two or three lessons a week, the master himself giving one lesson a month or so. Great artists—performers such as D'Albert, Paderewski, and others—sometimes give occasional lessons to artist pupils, but one goes to them for hints on style and interpretation, not for technical and systematic instruction. The Continental conservatoires are inexpensive—some of them, indeed, free—but although the small towns in which they are located offer advantages in the form of a musical atmosphere for the young student, the pianoforte teaching in some of them is based on out-of-date "Methods," and the lessons given are of little more than merely nominal duration; so that the student finds it necessary in many cases to pay for additional private lessons outside the institution.

Pianoforte Study in England. But, except for a perhaps cheaper and brighter life, there is no need for the ambitious pianoforte student to leave our own country; and, indeed, except for the sake of gaining a wider and more varied experience at the end of his student days, before settling down to a teaching or performing career, it is foolish of him to leave our shores, since our own schools and private teachers are really far stronger than the Continental piano teachers at present. The student must *hear* a great deal of good music; it is one of the most important factors in his education. Much good music can be heard in London and the provinces, orchestral, solo, instrumental, and vocal; and all the great performers visit us periodically. The pianoforte student must not neglect opera either, since much pianoforte music, many of Beethoven's sonatas and Chopin's compositions, for example, pre-suppose an acquaintance with dramatic diction, so to speak. The Royal Academy and the Royal College of Music can offer an all-round musical education second to none in Europe. For pianoforte playing we can nowhere get more satisfaction, more fruitful teaching, than at the Royal Academy, of which one of the professors has sent out the most complete and

scientific monograph on pianoforte touch and technique (in its widest sense) that Europe or America has yet seen. We mean the author of "The Act of Touch," etc., so often quoted in these pages, Tobias Matthay, a London-born German, whose interpretative teaching is as striking as his technical in its results. Students may enter the Royal Academy for one year, but three years is understood to be a course. They may enter at any time, although the academic year begins in September. Fees are thirty-three guineas per annum. Alike at the Royal Academy and at the Royal College, there are a great number of scholarships which can be obtained by those sufficiently talented at competitions, the dates of which are duly announced. And, of course, private lessons may be obtained of all the teachers of these institutions, if the student does not wish to join one of these.

Examinations. The "Associated Board," being a joint institution of the R.A.M. and R.C.M., is consequently the most esteemed examining body. Examinations in pianoforte playing are held by it all over the country and in the Colonies at local centres. The *professional* certificates obtainable are those of the R.A.M., the Metropolitan Examinations (Licentiate), held in September and at Christmas, and those of the R.C.M. (Associateship), held at Easter. It is now quite expected that young professional musicians should pass one of these examinations, and it is difficult to obtain positions at schools without them. Students of the R.A.M. and R.C.M. can, on leaving, obtain a teaching diploma, if proved deserving of such, and R.A.M. students who greatly distinguish themselves are awarded the A.R.A.M. (Associateship).

As to the preparation for examinations, even if one feels oneself fit for the work, it is safer not to hurry. We should take two years, preparing the prescribed work for both. When the stuff comes out *study* it carefully, make it our own, then lay it aside a little and take it up again to polish. Von Bülow said "there never was a piece composed yet that had no difficulties." Select difficult passages and work at them quietly and steadily; know them intimately on the keyboard and go over them always with concentrated attention. Then gradually work them in with the preceding and following bars until they are securely built into the edifice. Then beware, for although practice means that we are getting our fingers to find their keys semi-automatically, yet *we must never* let our playing get entirely automatic; it then gets dead and goes from bad to worse. We must keep the rhythm *alive, will* it every time we play, and quick movements will not then run away with us; we shall have them in rein.

Necessity for Regular Practice. Many students who succeed in playing a toccato-like movement fairly well at first, practise it into everything that is bad just because they do not attend to what they are playing, neither musically nor technically, and so the rhythmical grip is lost, and nothing then avails but to put the piece aside until such time as the mind can take it up afresh and give the needful vivid attention.

To gain endurance we must practise regularly, but with breaks; it is not wise to play more than two hours consecutively, and not even as long as this until we are well in training. Frequent quarters of an hour of tiring technical work suffice; rest brain and nerve and muscle, then return to work. Begin as early in the day as possible, and take frequent intervals for healthy outdoor exercise. The amount of practice will count for nothing unless it is *every day* begun well and kept on the right lines. We should begin with, and have frequent recourse to, the Daily Tests, quoted from Matthay's "Act of Touch" and "Relaxation Study."

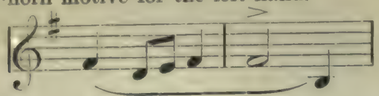
The Student's Piano. Secure as good a piano as possible; it is one of our best teachers, because of the wonderful variety of tone obtainable from it. It tempts one to paint with tone. Have a grand if possible. If we can afford only an upright (a cottage), we must get the best maker we can afford; and if we cannot buy outright, all the good makers offer the three years' system, which is better than hiring. The best makers are Bechstein, Steinway, Broadwood, Erard, and Blüthner, and some of the younger English firms are also rising in public estimation.

Performing and Memorising. Lastly, about performance. If we are amateurs we should try to play simple things to perfection, and should not attempt to perform to others things that present real difficulties to ourselves. Needless to say, we must memorise one or two short lyrics and keep them polished up ready for use. It will help greatly to memorise if we first *analyse*. Let us try it, say, for Grieg's "Elfin Dance" from his first book of "Lyric Pieces." The simplicity of the material and frequent repetitions make it comparatively easy. It is in the key of E minor, and the first five chords—all of them the chord of E minor save one—give the rhythmical germ of the whole. Note the deviation at the third chord from B and E by contrary motion to C, printed in small type.

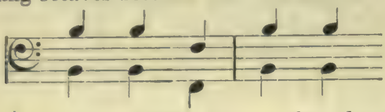
The following passage is again made out of the E minor chord, this time it is embroidered with passing notes:

Learn each of these little bits carefully and join them together. We shall not proceed further till we have absolutely mastered these two and their connection one with another. Next follows a repetition of the opening chord motive, this time on B minor; add this to the other two.

Then note specially, in what follows, the little fairy-horn motive for the left hand.



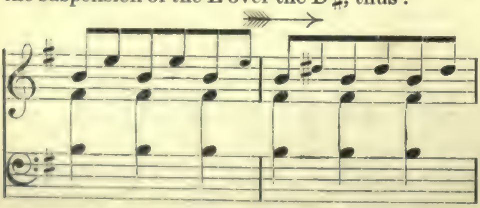
This requires very careful study and practice, and we must always *attend* to it, hearing the horns mentally before playing the passage, and listening to make sure that the horn passage really tells through the upper accompaniment. And now the whole thing is repeated. Then comes again the five-beat motive, very easy to remember this time, for it is in single notes, forming octaves between the two hands.



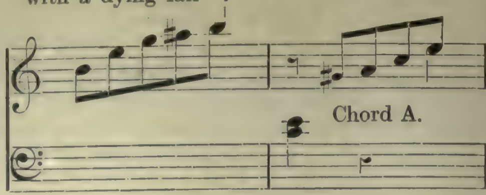
In the next passage observe that there are two persistently recurring notes, A♯ in the right hand and C♯ in the left, while the *moving* notes E, F, G, and G, F, E, are just the reverse each of the other.

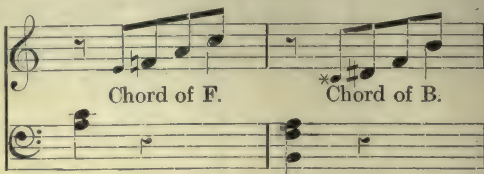
This fairy-tripping measure, after a repetition of the five elephantine footsteps, is again heard, although in the notation picture the A♯ appears now as B♭. Then follows an exact *imitation* of this a minor third higher, and still another and a higher, but this time not an *exact* imitation, for the bass here moves in *similar*, not contrary, motion to the other moving part.

The second of this pair of bars is re-echoed in the two bars that follow, the only fresh idea being the suspension of the E over the D♯, thus :

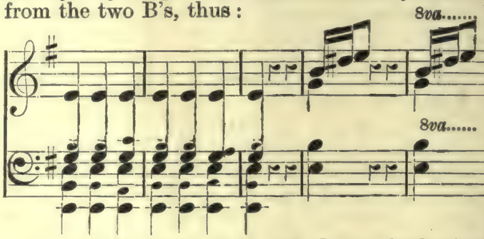


And now all is repetition *da capo*, till we reach the last line, the coda, the tail-piece, which enters suddenly after the latter part of our second motive, imitating and re-echoing it thus " with a dying fall " :





This re-echoing is based upon a series of chords, each introduced by a passing note half a tone below a note of the chord—these passing notes are printed in smaller type. Now we close with the opening chord motive, lengthened by two additional throbs, and note here again how simply variety in unity has been obtained—unity and variety have been said to be the keys to beauty—by simple deviations in contrary motion from the two B's, thus :



It concludes with these two dainty little elfin screeches on the chord of E minor with expressive interloping half-tone-below passing notes—D♯.

If we have never memorised before, we should try this, taking it quietly, perseveringly, intelligently, imaginatively, and—provided we do not let the mind wander—success is sure.

Nervousness. Most artists suffer from nervousness. If we could think more of composer and composition and less of ourselves we might get rid of it. As Matthay has pointed out, if only you succeed in really listening while you play, and realise that your audience is listening also to the *music*, and therefore not to you personally, that moment all nervousness disappears as if by magic. Practising clubs are useful. As members we may learn to play before others, which we should take every opportunity of doing. The key resistance varies on different instruments. It is well to be able to prelude that we may test this resistance sufficiently on a strange piano before beginning serious performance. We should practise preluding on series of chords and dare to improvise. If we persevere in this as in all else, what is exceedingly difficult to do at first becomes automatically easy in course of time, till we forget that we ever had to learn.

Pianoforte concluded

RADIUM AND THE WORLD

The Light Thrown by Radium upon the Origin and End of our Earth. The Rays and Energy of Radium. Radium and Life

Continued from page 1917

By Dr. C. W. SALEEBY

THE revelation of radium has led us to believe that the human race may now expect many more million years of sunlight than we had hoped for ere the discovery of radium upset the accepted cosmical time-table. The accepted view as to the sun's heat was, as we have already seen, that it is produced by a continuous gravitational shrinking of his substance. Helmholtz, Lord Kelvin, and many other physicists have addressed themselves to this problem, and the verdict passed upon humanity was that it cannot expect more than 5,000,000 years to live—probably 3,000,000 would be nearer the mark. After that, assuming that the sun received no help from anything but his own shrinkage, he would be too cold to support life upon the earth. Reasoning from similar evidence the physicists were able to assign his age to the sun; but while they declared that he may be perhaps 25,000,000 years old, the geologists declared that the crust of the earth was far older, dating from hundreds of millions of years ago. There the controversy long stood. The late Marquis of Salisbury, in his once-celebrated presidential address to the British Association, in 1894, made much of this enormous discrepancy between the two estimates. It served his purpose, which was to discredit the theory of evolution.

Is there Radium in the Sun? But if there be radium in the sun, then he has in it another and most potent source of his light and heat besides the shrinkage on which the physicists were calculating; and his age may well be as long as that which the geologists demand as necessary in the past for the formation of the earth's crust. Furthermore, if there be radium in the sun, there is no reason why he should not be vivifying a happy and fruitful earth ten or fifty or a hundred million years hence, instead of leaving posterity to die of frostbite after only three million years.

Let us glance for a moment at the reasons we have to believe that there is radium in the sun. In the first place, we have the fact, proved by Sir William Huggins and his followers, that suns and stars and comets contain just the elements that occur on the earth, the whole universe being thus made of the same material. Earth and sun were one in the nebula from which the solar system was formed, and therefore it would seem highly probable that any element occurring on the earth will also be present in the sun. A second reason for believing that there is radium in the sun is, as we have already seen, that its presence there would reconcile the disagreement between the cosmical time-tables of the geologists and the physicists, who are pluckily studying all time and all existence from the surface of this "luke-warm bullet," as Stevenson called the earth. A third reason is to be found in the fact that helium is known to be evolved from radium on the earth, and thus its presence in the sun suggests that there must be radium there also.

Electrons from the Sun. But the reader will ask whether there is not a very simple and definite manner of determining the answer to our question. If radium is truly an element, he will say, it must have a characteristic spectrum of its own. The lines characteristic of this spectrum should be recognisable in the spectrum of sunlight if radium be indeed present in the sun. Now, as a matter of fact, numerous observations have been made without obtaining any definite evidence from the spectroscope of the presence of radium in the sun. This fact, however, does not outweigh the positive arguments which we have already enumerated and others which are frequently being added to them—for it seems probable that the characteristic contributions which radium might be expected to make to the spectrum of sunlight may be absorbed by our atmosphere in such a fashion that they cannot be detected at its bottom where we live. There is, nowadays at any rate, no doubt that the sun gives out electrons just as radium does. One of the theories advanced for the formation of a comet's tail—a subject to which reference was made when discussing radiation pressure in the course on Physics—was that these electrons hit a comet and develop its tail by causing its lighter parts to stream behind it, for a comet does not develop a tail until it approaches the sun, and the tail is always turned away from the sun. The electrons given out by the sun are believed to strike our atmosphere, and thus, in certain conditions, to make the rare gas krypton that exists in the topmost layers of the atmosphere to become luminous; and that, it is believed, is the cause of the phenomenon known as the *Aurora Borealis.*

The Cooling of the Earth. But, as a matter of fact, we need not wait for a positive answer to our question—at any rate in so far as we ask it in the desire to explain the discrepancy between the two rival estimates of the age of the earth. Professor Ernest Rutherford, of the University of Montreal, the most distinguished student of Professor J. J. Thomson, of Cambridge, has gone far to solve this difficulty for us. One of the means by which Lord Kelvin estimated the age of the earth consisted in a calculation of its "secular cooling"—the rate at which the heat is radiated into space. But Lord Kelvin could not take into account, when he made that calculation, the remarkable fact lately discovered by Rutherford, which is that

radium—or, at any rate, radio-active matter—is, so far as his observations have hitherto gone, a constant constituent of the materials that compose the earth's crust. Now Rutherford has calculated the proportion in which it occurs in the earth's crust, has estimated the amount of heat which such a quantity of radium must produce, and has actually shown that if his calculations be correct, the radium of the earth's crust suffices by its production of heat completely to replace and thus compensate for the heat which the earth constantly loses by radiation into space.

The Rays of Radium. Those immature atoms of helium, as we now believe them to be, which physicists call the *Alpha* rays, consist, of course, of material particles; they are not mere vibrations in the ether, like sunlight, the Röntgen rays, heat rays, electric waves, and most of the others with which readers of the course on Physics are more or less familiar. But the emission of these rays, and the production of the celebrated emanation to which they give rise, constitutes only one of the many activities of radium. There is a great deal more that goes on within the spinthariscope than the zinc sulphide paper reveals to us. The *Beta* rays, so-called, must later be discussed; but we may here dispose of the third variety of rays which are constantly being given off by radium, and which are known as the *Gamma* rays (Alpha, Beta, and Gamma are, of course, the first three letters of the Greek alphabet). Now the *Gamma* rays of radium are either identical with the Röntgen rays, which are now almost a commonplace, or are at any rate nearly identical with them. We may guess that it is the occurrence of these rays that explains the similarity, in the power of curing certain diseases, between radium and the Röntgen rays. Like these latter, the *Gamma* rays have the most extraordinary penetrating power. It is said that they can be detected after passing through five inches of armour plate. Not only does radium give out these rays, but it has the power of picking up, so to speak, any Röntgen rays that may be about. If you are looking at a piece of radium in the dark through a fluorescent screen, you may notice that it shines more brightly than before if Röntgen rays are being generated in the same room, showing that it has the power of picking them up and giving them forth again in an altered form.

What Half a Pound of Radium Would Do. But in addition to the three kinds of rays to which special names have been given, radium is ever giving out a large quantity of those rays which we call *heat*. Whatever the temperature of its surroundings, it is always a little hotter. So powerful is this action, and so nearly inexhaustible, that if you could obtain a sufficient supply of radium—probably half a pound would be quite enough—it would keep a room warm, not merely during your lifetime, but for hundreds of generations after you. We may note, however, that, as Professor Curie has remarked, one would not care to be in the same room as half a pound of radium.

Fastest Moving Matter Known. And now we turn to what are, in some respects, the most important products of radium. Like the *Alpha* rays, the *Beta* rays consist of particles. It is no easy matter to say, however, of what the particles consist. The particles that constitute the *Alpha* rays may freely be described, indeed, as particles of matter. As we have seen, they are really atomic particles. But the particles that constitute the *Beta* rays are of proportions almost infinitely smaller than those of the smallest atom. The name applied to them by their most distinguished student, Professor J. J. Thomson, is *corpuscles*: the most popular name, however, is *electrons*. These fly out from the radium at a most amazing speed. Sir Oliver Lodge has said of them, "Three hundred times faster than the fastest flying star, they are the fastest-moving matter known." Until the discovery of radium, it was thought that the greatest speed ever obtained by matter was that of certain of the "runaway stars." Arcturus, for instance—whom everyone should know who can recognise the Great Bear—moves at the rate of about one hundred miles a second, we used to be told, but that is a mere dawdle compared with the speed of these electrons.

Matter is Electricity. Now, each of these electrons or corpuscles carries with it a tiny charge of negative electricity. They are believed to be all of the same size; and the size is the same whether the electron be given out by radium or by thorium, or by uranium, or by any other radio-active substance. Hence it is that these substances are able to affect a delicate indicator of electricity; and it was by this means that Madame Curie, under the guidance of her husband, was enabled to discover radium. She began with two tons of pitch-blende, the mineral in which radium is principally found, and ended some months of hard work by obtaining one-tenth of a grain of radium. This property of affecting an electric indicator was the only guide and test that she had in tracing this minute quantity of the unknown substance for which she was seeking.

We have said that the electrons *carry* a charge of negative electricity, but now it seems probable that each of them *is* a charge of negative electricity, or, indeed, is *an atom of electricity*. And when we go on to inquire where these electrons come from, and what they are doing before they leave the radium, we reach the amazing conclusion that atoms of matter are made of atoms of electricity! As a result of the revelations of radium, not only do we know that one kind of matter may be changed into another, but we have found that matter itself consists of electricity.

The Marvels of an Atom. Readers of this and its companion course [PHYSICS] are already familiar with Lord Kelvin's estimate of the size of an atom. Roughly speaking, we may say that, if a drop of water were magnified to the size of the earth, the atoms within it would be somewhere between the size of small shot and cricket balls. This gives some faint

idea of the size of an atom. But now imagine an atom of radium magnified to the size of St. Paul's Cathedral. Under such circumstances it would appear to consist of about one hundred and fifty thousand tiny particles, each of which is one of the electrons we have been speaking of, and the size of those electrons would be about the size of this dot, called a full stop, or period (.). Try and realise, if you can, from Lord Kelvin's illustration, what the size of an atom is, and then try to realise that the ratio of an atom to an electron—the ratio of an atom of matter to one of its constituent atoms of electricity—is the ratio of St. Paul's Cathedral to a full stop. Obviously one hundred and fifty thousand full stops would not fill St. Paul's Cathedral. And so far away from one another are the electrons in an atom that the distance is comparable to the distance between the planets of the solar system. Relatively to their size, the electrons are as far from one another in this inconceivably tiny atom as the earth is from Mars, which has an average distance from us of sixty millions of miles.

The Atom and the Solar System. This is by no means the only resemblance between an atom—or atomic system, as we should call it—and the solar system. Just as the planets are revolving round a centre, so the electrons in each of the atoms that go to make up those planets are also revolving round an atomic centre—revolving at a speed hundreds of times faster than the speed of the planets which they compose. And it is supposed that the electrons are constantly colliding with one another in their mad race within the atom, and the result of these collisions is to expel some of them from the atomic system. The electrons thus expelled constitute the *Beta* rays of radium. So small are the electrons, as compared with the atoms of ordinary matter, and so great is their velocity, that they pass through such a substance as the brass tube of the spinthariscope almost as if it were not there. The *Alpha* rays consist of bigger particles, and they are stopped with ease, but the *Beta* rays need a considerable thickness of matter to arrest them. But when they are arrested they can be shot forth again, just as they were from the radium itself. This explains the fact that ordinary substances, such as glass, which have been kept near radium, themselves become radio-active after a time. And this is what makes one think that there is an analogy between radium and genius. Both get their energy from within, and both can impart some degree of their powers to their neighbours.

A New Source of Energy. This property of evolving power within itself is one of the most extraordinary facts about radium. At first it was thought to get its power from sunlight, or from some sort of unknown waves in the ether. Then Sir William Crookes thought that the molecules in the air might constantly be striking the radium and so be imparting energy to it. But now we know that the energy of radium is derived from the motion of its electrons. And this is a new source of energy, greater than any which has hitherto been known.

The ingenious suggestion of Sir William Crookes that radium takes up the kinetic energy of the gases of the air is now known not to meet the requirements of the case. The view of Lord Kelvin that radium obtains its power by absorption of sunlight or of some other form of waves —known or unknown—in the ether has been abandoned even by its distinguished author, who has given his adherence to another view, now established beyond dispute and known as the *disintegration theory*. This is the theory the truth of which we have assumed all along. It is the view which asserts that the atom of radium itself is the seat of gigantic energies which are quite adequate to explain all the energy-producing properties of radium, without the need of any assumption that the radium really obtains its energy from without. This theory further maintains that the external energies of radium can be manifested only at the cost of its internal energies. If, indeed, this were not so there would be doubt thrown upon the doctrine of the conservation of energy. Thus, we believe it is only in virtue of the disintegration of its atoms that radium is enabled to exercise its remarkable properties. Hence the name of this theory.

Radio-activity is Universal. Radium is, of course, by far the most powerfully radioactive of all known bodies. It can be obtained with a radio-activity considerably more than a million times as great as that of uranium. Thorium also is very definitely radio-active. To these we may add the names of polonium and actinium, so-called, though there is now little doubt that these are merely names for the transient products of the disintegration of the radium atom.

But the truth is beginning to be recognised that radio-activity is not confined to the obviously radio-active elements. The wider our inquiry the more certain does it appear that radio-activity may be found wherever we look closely enough for it. Even ordinary air is radio-active, while the soil-air and that found in cellars and caves is still more so. Deep well-water at Cambridge was found to be radio-active, and then the waters at Bath and in many other places. There are, of course, two possible explanations of this fact. It may be, in the first place, that minute traces of radium or of one of the other markedly radio-active elements are distributed throughout all other forms of matter. Or, on the other hand, it may be that all matter is radio-active in itself. But if this be so, how are we to explain the very marked differences in the degree with which this property is manifested? The explanation is not far to seek. The three most markedly radio-active of all the elements are the heaviest three elements. Radio-activity must be regarded as an intrinsic property of large and complex atoms. Of course, these terms are relative, and there is no inherent reason why we should suppose that even the simplest and smallest atoms, such as those of hydrogen and

helium, are destitute of this property. But if radio-activity be an indication and consequence of the disintegration of the atom, it is only reasonable that it should be manifested in greatest degree by those very heavy and complex atoms which have a very long range of consecutive change before they are resolved into simpler bodies.

Radium and Natural Selection. In a previous paragraph we hinted very briefly that the law which Darwin called *Natural Selection*, and Herbert Spencer called the *Survival of the Fittest*, may possibly have its realm of application in chemistry as well as in biology. We can readily understand how it might be applied to chemical compounds: innumerable compounds may be formed in the universe, but only the more stable ones will tend to persist.

Now that radium has revealed to us an entirely new conception of the origin and history of atoms, the question arises whether natural selection is not also applicable to them. The idea of natural selection is far older—ages older, indeed—than Darwin's application of it to organisms in 1859, or Spencer's application of it to societies eight years before. Indeed, the very first occurrence of this idea, so far as can be discovered, must be credited to the great Greek thinker, Empedocles, the most distinguished pupil of Democritus, whom we have already described as the veritable founder of the atomic theory. Reflecting upon the atoms conceived by his master, Empedocles is reported to have thought that innumerable species of atoms would be born, but that only those would survive which were best adapted to the conditions of the environment. Thus it was of atoms that the idea of the survival of the fittest was first conceived, and it is again to atoms that it has most lately been applied. The obvious reason why there is so little radium in the world is that its atom is unstable. Specimens of it are constantly being produced, but they cannot survive in the conditions in which they find themselves. We must thus regard the seventy-five or eighty different kinds of atoms with which we are acquainted as the more or less stable survivors from an absolutely indefinite number of possible atoms, most of which may have come into existence again and again, but which, like the dodo or the mammoth, have been exterminated by natural selection.

The Small Supply of Radium. The reader who realises that in radium we have discovered a source of almost inexhaustible power may be inclined to ask to what uses it has been turned. But in the first place it is necessary to note that the total amount of radium that has hitherto been isolated is extremely small. The use of the word *isolated* leads us to observe, in passing, that radium has not yet been obtained in its elemental form. It is known merely in the form of its simpler compounds, especially the chloride and bromide. But even of these the total amount yet obtained is almost ridiculously small. The difficulties of obtaining them are enormous, and though the process has been considerably improved since Madame Curie first performed it, it has been calculated that there is not much more than one gramme of pure radium salt in the world—that is to say, about 15 grains, worth about £3,000. Even this minute quantity exists only in the form of a few milligrammes here and a few there. Thus, whilst we may easily demonstrate that, let us say, half a pound of radium would drive an ocean liner for decades or centuries, the realisation of such speculations is not within the range of practice. Hitherto the direct utilisation of the energy of radium has been accomplished only for purposes of demonstration, as, for instance, in the radium clock. But, as we have already noted, radium has been turned to practical purposes in medicine and surgery.

Radium and Living Matter. Needless to say, the action of radium upon different forms of living matter has been the subject of close inquiry during the last few years. So far as the very lowest forms of life are concerned, it seems that under certain conditions radium acts as an antiseptic, though not a particularly potent one. Its powers in this direction have certainly been exaggerated. On the other hand, it is quite certain that, under particular conditions which we do not yet understand, the very radium which in other circumstances destroys malignant tumours, has a tendency to produce them, apparently having a stimulant action upon certain forms of living matter. The same paradoxical facts have been observed in the case of the Röntgen rays. It would certainly be an amazing thing if radium did not exert certain influences upon living matter. If we consider that everything in its neighbourhood is exposed to the constant evolution of heat, to a constant bombardment by particles of atomic size, and by the sub-atomic negatively electrified particles which we call electrons, and also to the constant reception of the *Gamma* rays, we can scarcely doubt that living matter may be very markedly and very variously affected by its influence.

How did Life Come to Earth? A sensational contribution to this subject has lately been made by Mr. Butler Burke, working at the Cavendish Laboratory of the University of Cambridge. Without venturing too far into biology, we may remind the reader that all forms of life are supposed to arise at the present day exclusively from pre-existing forms of life. Thus, it becomes a question how life first arose upon the planet: whether the primal origin of life was miraculous; whether, as Lord Kelvin suggested, the first germs of life were borne to the earth on a meteorite from the "moss-grown ruins of another world," or whether life first arose by natural processes from lifeless matter—if, indeed, it does not now so arise? But experiments undertaken to solve this last question—the question of spontaneous generation—seemed to show that life does not and cannot so arise in lifeless matter; and this was a most anomalous and inexplicable result for those who believed in the uniformity of Nature. Dr. Charlton Bastian, F.R.S., has persistently denied from the first the soundness of the logic with which these experiments were interpreted, but he was ignored.

Living and Dead Matter. Lately, however, Mr. Burke began to attack the subject, and the considerations which led him to it are of such interest to the philosophic student of chemistry that we may discuss them here. In 1875, Professor E. Pflüger, of Bonn, after many experiments and much thought, concluded that the difference between the living proteid molecule and the dead proteid molecule, such as a molecule of white of egg, lies in the manner of their oxidation. White of egg can be oxidised, or burned, if energy be granted it from outside. The living proteids of protoplasm undergo intra-molecular oxidation, in virtue, said Pflüger, of some unknown source of energy which imparts internal power to the molecule. Pflüger suggested that the chemical body called cyanogen (CN), the simplest possible compound of carbon and nitrogen, might be the source of the internal activity of the living molecule. Cyanogen occurs in all living matter, and it can be produced at incandescent heat. Hence, this was at least one theory which was compatible with the origin of life upon the heated earth of the remote past. Now Mr. Burke—who has been working in seclusion for 10 years—attempted to put Pflüger's theory to the proof. But he found that the intimate union of cyanogen with the most likely substances produced no results. Pflüger was wrong. But, nevertheless, Pflüger may have been right in his theory—wrong merely in seeking to apply it to cyanogen. Pflüger knew nothing of radium, which is a source of potential energy millions of times more abundant than even that of the active cyanogen radicle.

Cyanogen, we have already seen, is produced at incandescent heat, and was thus suggested as the prime source of the molecular energy which resulted in life a hundred million years ago, to quote an estimate of Lord Kelvin's. But radio-activity is manifested at equally high temperatures, and though it is now known that radium exists for but a few thousand years, yet it is being constantly evolved from uranium; and indeed, radio-activity is probably a property of all matter. Doubtless, then, radio-activity was in force on the earth a hundred million years ago.

An Extraordinary Discovery. But radium, the most radio-active of substances, only occurs to the extent of a few grains in a ton of pitch-blende, and so Mr. Burke's first proceeding was to obtain some radium in a much more concentrated form than—so far as we know—it ever occurs in Nature, and to see whether, under the most favourable conditions, such radium could impart to proteid molecules that internal energy which Pflüger declared to be the great characteristic of the living molecule.

For this purpose Mr. Burke prepared solutions of beef gelatin, usually known to the bacteriologist as bouillon, and sought to observe the action of radium upon them. So extraordinary and seemingly incredible was the result that he was compelled to devise a number of experiments in order to test it. He found that various radio-active bodies besides radium induced the same sequence of events; but we may continue to speak of radium alone, merely noting that the results may be assumed to be due to that property of radio-activity which radium possesses in pre-eminent degree, but which is displayed by the constituents of earth and sea and air alike—a fact of the first importance in this connection.

Mr. Burke found that when a few grains of radium chloride or radium bromide were sprinkled upon the surface of beef gelatin, the whole being subjected to the most efficient processes of sterilisation, such as no known form of living matter can survive, there appeared in the tubes thus treated (but not in the "control" tubes, which were similar in all respects save for the addition of the radium) a growth which any bacteriologist would have pronounced to be due to bacteria; this in tubes which had been subjected to a temperature of 130° C. under high pressure for half an hour! If anything was out of the question, it was that this growth was bacterial. However, crystals grow, and this might be a hitherto unknown kind of crystal, due to the action of radio-activity upon beef gelatin.

Growth Induced by Radium. The next step was plainly to examine a portion of the growth under the microscope. A magnification of about 1,200 or 1,500 diameters was used, and the growth was seen to consist of exceedingly small, rounded bodies, containing a somewhat darker structure in the centre. The only known crystal they resembled was a form in which calcium carbonate occasionally occurs; but these bodies were many times smaller than any such crystals, and the structure they contained looked exactly like the nucleus of a living cell, such as is not seen in these crystals of carbonate of lime; examination with the polariscope showed that these bodies had none of the characters which crystals display on such examination by special kinds of light. Thus there was abundant evidence to negative the view that they were crystals—evidence that would suffice even were there not positive evidence the most astounding in proof of the view that they were something else.

Organisms or Crystals? The results were submitted to one of the leading bacteriologists of the day, who, failing to find any defect of technique in the sterilisation of the tubes, examined the growths under the microscope, and pronounced the opinion that these objects were not bacteria. It was found that they had nuclei—unlike any known bacterium; it was found that they were soluble in warm water of a lower temperature than that in which bacteria dissolve; and it was found that they disappeared from the microscopic slides when these were exposed to diffused daylight, but returned after a few days in darkness. This is not the way with bacteria; when they dissolve there is an end of them—they are dead. But these things dissolve in daylight and reappear in the dark.

If, then, these things are not crystals and not bacteria, are they some new form of living matter produced by the action of sterilised radium on sterilised gelatin? It is found that when a

portion of the growth is removed from the original tube, and placed—with aseptic precautions—on fresh sterilised gelatin, it continues to grow, though it would appear to have been removed from the action of the radium. Similarly, we saw that these objects reappeared on slides from which they had disappeared. Thus it would appear as if the radium had initiated a process which can continue without its assistance. But the most striking fact is yet to come.

Radiobes. Mr. Burke found that these objects, which he calls *radiobes* (from radium and Greek *bios*, life), never grew beyond a certain limited size, about one seventy-thousandth of an inch in diameter. When this limit is reached, they divide. This subdivision has been photographed, and is not open to dispute. Now, we believe that nothing but matter which is alive—in the strict biological sense—undergoes that "continuous adjustment of internal to external relations" which is implied in the act of subdivision when a certain size is reached. Herbert Spencer, who framed that profound definition of life which has just been quoted, was led to ask why living cells ever divide, why their size is always limited. He answered that the surface of a cell must always bear such a proportion to its mass that sufficient nutriment can pass through it. The larger the cell the smaller the ratio of its superficial extent to the mass—or, in metaphor, the bigger the body the smaller its mouth. Hence, the cell must divide its mass, thus greatly increasing its surface, and enabling growth to continue. It is a typical case of the adjustment of inner to outer relations ; and, judged by this comprehensive but strict definition of life, the objects produced by the action of sterilised radium on sterilised bouillon are alive—they are *radiobes*.

A Theory of the Origin of Life. The beef gelatin of Mr. Burke's experiments was exposed, as we have observed, to much more potent radio-activity than is to be found in nature. But that which much radio-activity can do in twenty-four hours, a little radio-activity, such as that of the earth and sea-water, may do in, say, a hundred thousand years. Why not ? May not life have originated, then, by the prolonged action of radio-activity upon those inorganic substances of earth or sea, which contain oxygen, carbon, and nitrogen ? (In a previous section, we noted Dr. Bastian's demonstration that sulphur and phosphorus are not, as was formerly thought, essential to living matter.) Obviously, this question cannot be answered save by the lapse of time. There may be the highest probability, but not demonstration. Mr. Burke is contemplating, however, certain experiments which may be entrusted to the care of the authorities of the British Museum or some other responsible body, and which may ultimately enable the question to be answered.

The Limits of the Conclusion. Assuming for the present that Mr. Burke's experiments have the significance which he attaches to them, let us carefully delimit the measure of what they have demonstrated. Because certain radium salts, in the hands of living man, can produce life in lifeless media which have been derived from the living ox, we may not claim to have explained the origin of life on the lifeless earth, where neither man, nor beef gelatin, nor chemical laboratories were to be found. It is true that synthetic chemistry may very soon be able to build up the constituents of beef gelatin from their elements ; but even if this were so, *intelligence* would still have to be reckoned with in Mr. Burke's experiments : and it is proposed to deny the action of intelligence in the first origin of life upon our planet. Only the very hasty and illogical, therefore, will jump to the conclusion that, even at their highest valuation, Mr. Burke's experiments have solved the age-long question. At the most, they have merely shown that life may arise under certain conditions in so-called lifeless matter.

The Old Definition of Life. The most striking fact of the controversy which still rages, and will probably long continue to rage, about this subject is the difficulty of framing an adequate definition of life. The truth is that the whole interest of the controversy, for nearly all of us, lies in the assumption that there *is* an essential difference between the living and the lifeless. It dates from the time when men talked of dead matter, and shared Plato's contempt for "brute" matter. But let us just consider the case of radium itself in this connection, quite apart from Mr. Burke's experiments. The old definition of life, which we owe to St. Thomas Aquinas, was that life is *self-movement ;* and when we come to analyse the various definitions that have been framed since his time, we find that this is the essential idea of most of them. Yet, if life is self-movement, what are we to say of radium itself ? It answers precisely to the definition. Its atoms are in a state of the most energetic and complicated movement, which owes absolutely nothing whatever to the incidence of external energies upon them, but which, on the contrary, causes them to radiate energy.

The New Definition of Life. We are very far here from maintaining that the atom of radium is alive in the sense that the living cell is alive. But we would insist upon this: that, in the light of the revelations of radium as to the structure of matter—and entirely without reference to the work of Mr. Burke—it is no longer possible to hold that there is an abysmal gap between living and lifeless matter. Radium has taught us that so-called dead or brute matter is, in a sense, very much alive ; and we may very gravely doubt whether any definition of life can now be framed that includes all the known forms of admittedly living matter whilst excluding all those forms of matter which are generally regarded as lifeless.

So much for one of the many contributions of radium to the philosophy of science. The reader who is interested in the subject, and especially in the relations of recent discovery to the theory of universal evolution, may be referred to the present writer's book, "Evolution the Master-Key" (Harper & Bros., 1906), where a fuller treatment of the subject is possible.

Continued

EXAMINATION TEXTBOOKS

Examinations for the Institute of British Architects—continued. The "Final." List of Helpful Textbooks for Examination Candidates

By GASPARD TOURNIER

Final Examination. The preliminary work submitted for the final examination by the Royal Society of British Architects is to be on sheets half double-elephant size, 27 in. by 20 in. [See page 1912.]

1. A study of ornament from the round, shaded.

2. A set of working drawings of a design by the candidate of a building of moderate size, such as a country house, a school, or local institution; everything usual on finished working drawings to be shown, including drainage, also some leading details on a larger scale, and a perspective of the exterior.

3. Drawings of some historical building, or part of one, made from actual measurement, with details and figures denoted, accompanied by the original figured sketches plotted on the spot.

4. A sheet of diagrams of constructive masonry or brickwork, such as arches or groined vaults.

5. One sheet of diagrams of a roof truss of steel, 40 ft. span or over, with large scale details and calculations of the strength of each part worked out.

6. An adequate number of sketchbooks or other satisfactory evidences of having followed the carrying out of building works, with notes and sketches of the progress and conduct of such works, and of the study of buildings and travel.

Textbooks. The examination starts with the designing of a stated building of moderate size, which the candidate has to do, such as a golf club-house, parsonage, cottage hospital, or a part of a more important edifice, with constructive details and ornament, and a sketch of the exterior in perspective. The subject will be communicated in general terms to the candidate some days before the sitting. This item has allotted to it 350 possible marks out of a total of 1,000 for the entire examination, so that it is of primal importance.

For remaining subjects the student should consult the textbooks, to which matter we will now refer. At the end of the written examination there is an oral one on the same lines as that of the Intermediate.

"INTERMEDIATE" TEXTBOOKS.

In these modern days the number of textbooks for the Intermediate Examination is very great. Many excellent books cover the same ground in one way or another, but none can, from the nature of things, give all that is required in every direction, nor quite point out the distinction between essentials and non-essentials, or foresee and remove the stumbling-blocks of each student. No one can hope to be engineered through any course of study by books alone without individual help as he proceeds.

The following books can be recommended in the Intermediate Examination.

Classic Architecture and its Ornament. "The Orders of Architecture," by *R. Phené Spiers*; ditto by *C. Normand*; "Civil Architecture," by *Sir W. Chambers*; "Ornamental Sculpture," by *L. Vulliamy*; "Classic Ornament," by *H. D'Espony*; "The Architecture of Greece and Rome," by *W. J. Anderson* and *R. Phené Spiers*.

Gothic Architecture and its Ornament. The Works of *A. Pugin*; "The Analysis of Gothic Architecture," by *R.* and *J. A. Brandon*; "The Glossary of Terms used in Grecian, Roman, Italian, and Gothic Architecture," by *J. H. Parker*; the Works of *J. K. Colling*; "Architectural Parallels," by *Edmund Sharpe*; "The Styles of Architecture in England," by *T. Rickman*; "Historic Ornament," by *R. Glazier*.

History of Architecture. "The History of Architecture in all Countries," by *J. Fergusson*; "The Principles of Design," by *E. L. Garbett* (Weale's Series); "Lectures on Mediæval Architecture," by *Sir G. G. Scott*; "History of Architecture on the Comparative Method," by *Banister Fletcher*; "Histoire de la Vie et des Ouvrages des plus célèbres Architectes," by *A. C. Quatremère de Quincy*; "Histoire Générale de l'Architecture," by *D. Ramée*; "History of Architecture," by *A. D. F. Hamlin*; "Architecture of the Renaissance in Italy," by *W. J. Anderson*; "Early Renaissance in England," by *J. A. Gotch*.

Building Materials and Construction. "Builders' Work" and "The Building Trades," by *H. C. Seddon*; "Notes on Building Construction" (vols. i., ii., iii.), published by Rivington; "Tredgold's Elementary Principles of Carpentry," Ed. *J. T. Hurst*; "Foundations and Concrete Works," by *E. Dobson*; "The Construction of Roofs, Wood and Iron," by *E. W. Tarn*; "The Joints Made and Used by Builders," by *W. J. Christy* (the last three in Weale's Series); "The Strength of Materials and Structures," by *Sir John Anderson*; "Practical Masonry," by *W. R. Purchase*; "Practical Building Construction," by *J. A. Allen*; "Building Construction," by *C. F. Mitchell*; "Modern Practical Joinery," by *G. Ellis*; "Strains in Structures," by *Middleton*.

Geometry and Projection. "The Rudiments of Masonry and Stone Cutting," by *E. Dobson*; "Descriptive Geometry," by *J. F. Heather* (both in Weale's Series); "Practical Geometry," by *E. W. Tarn*; "Geometry," by *Rawle*.

Books of general reference useful over the whole ground are: "The Encyclopædia of Architecture," by *Gwilt* (1888 edition); "The Dictionary of Architecture"; also reference pocketbooks, such as *Hurst's* and *William Young's*, published by Spon.

"FINAL" TEXTBOOKS.

Many of the books mentioned carry the reader further than the Intermediate Examination, and serve towards the Final one. In addition to these the following works are more specialised:

Classic Style and its Derivatives. "Temples at Ægina and Bassæ," by *C. R. Cockerell*; "Principles of Athenian Architecture," by *F. C. Penrose*; "Antiquities of Athens," by *Stuart* and *Revett*; "Antiquities of Ionia," published by the Dilettanti Society; "Magna Græcia," by *W. Wilkins*; "Erechtheum," by *H. W. Inwood*; "Palace of Diocletian at Spalatro"; "Palmyra and Baalbec," by *Wood* and *Dawkins*; "Constantinople," by *W. Salzenburg*; "Byzantine Architecture," by *Texier* and *Pullan*; "Architectural Antiquities of Rome," by *Taylor* and *Cresy*; "Edifices de Rome moderne," by *L. Letaronilly*; "Renaissance in France," by *A. Berty*; "Motifs Historiques," by *C. Daly*; "Brick and Marble," by *G. E. Street*; "Later Renaissance Architecture in England," by *Belcher* and *Macartney*; "Historic Ornament," by *J. Ward*; "Italian Renaissance," by *G. J. Oakeshott*; "Renaissance Architecture in England," by *R. Blomfield*; "London Churches," by *G. H. Birch*; "English Interior Woodwork," by *H. Tanner*; "Architectural Works of Inigo Jones," by *Inigo Triggs* and *H. Tanner*.

Gothic Subjects. "Analysis of Ancient Domestic Architecture," by *Dollman* and *Jobbins*; "Churches of the Middle Ages," by *Bowman* and *Crowther*; "Dictionnaire Raisonné de l'Architecture Française," by *Viollet-le-Duc*; "Gothic Architecture," by *T. Rickman*; "Gothic Mouldings," by *F. A. Paley*; "Decorated Window Tracery," by *E. Sharp*; "Vaulting," by *R. Willis* (Transactions of R.I.B.A., 1842); "History of Gothic Architecture," by *E. S. Prior*; "The Open Timber Roofs of the Middle Ages," by *R.* and *J. A. Brandon*; "Architecture du Ve au XVIIe Siècle," by *J. Gailhabaud*; "Study Book of Mediæval Architecture," by *T. H. King*.

Materials in their Nature and Application. "Treatise on Building and Ornamental Stones," by *E. Hull*; "Timber and Timber Trees," by *T. Laslett*; "Timber and Some of its Diseases," by *H. Marshall Ward*; "Building Materials; their Nature, Properties, and Manufacture," by *G. A. T. Middleton*; "Decorative Plaster-work," by *Millar*.

Sanitary Science. "Annotated Model Bye-laws," by *Knight*; "Plumbing Practice," by *Clark*; "Sanitary Engineering," by *E. C. S. Moore*; "The Soil in Relation to Health," by *Miers* and *Crosskey*; "Healthy Dwellings," by *Sir Douglas Galton*; "Sanitary House Drainage," by *T. E. Coleman*; "Practical Hygiene," by *E. A. Parkes*.

Land and Site Surveying. "Mensuration," by *Baker* (Weale's Series); "Practical Trigonometry," by *Adams*; "Surveying and its Instruments," by *Middleton*; "Surveying and Levelling" and "Field Work and Instruments," by *Walmisley* (both in the technical series published at "The Builder" Office).

Strength of Materials and Construction. "Shoring and Underpinning," by *C. H. Stock*; "Carpenter's and Joiner's Assistant," by *J. Newlands*; "The Science of Building," by *E. W. Tarn*; "Practical Treatise on Strength of Materials," by *T. Box*; "Strains in Ironwork," by *Adams*; "Notes on Building Construction" (vol. iv.), published by Rivington; "The Principles of Graphic Statics," by *G. S. Clarke*; "Testing of Materials," by *W. C. Unwin*.

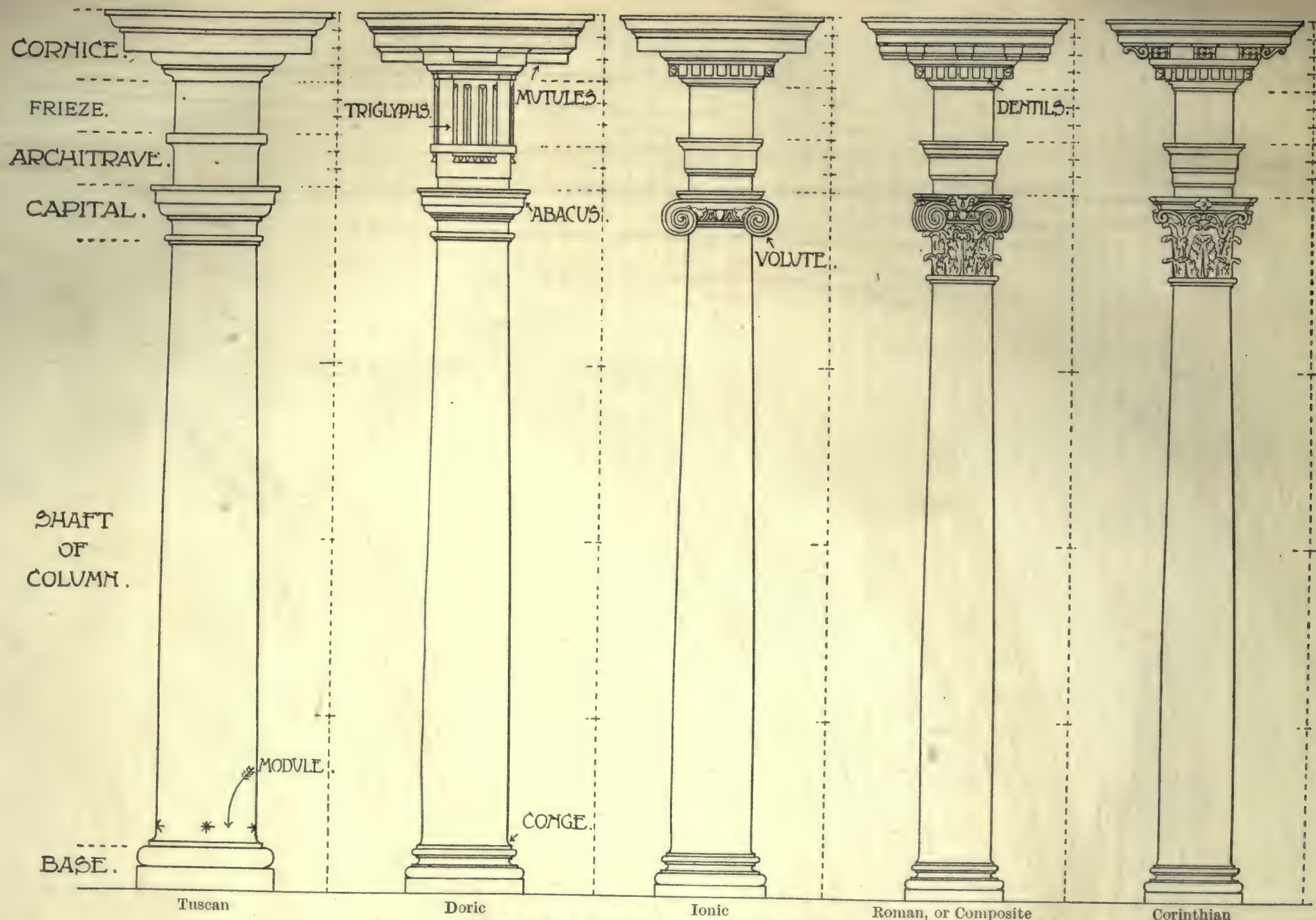
Specifications and Contracts. "The Architect's Legal Handbook," by *Jenkins* and *Raymond*; "The Schedule of Conditions for Building Contracts," issued by the Royal Institute of British Architects; "The London Building Acts," "Building Leases and Building Contracts," by *A. Emden*; "Architect's Liabilities," by the same writer; "Ancient Lights," by *Holden*; "Dilapidations," by *Banister Fletcher*, and "R.I.B.A. Handbook" on the same subject; "Student's Guide to Measuring and Valuing Artificer's Works," by *Dobson* and *Tarn*; Works by *J. Leaning* on Quantity Surveying and Specifications; "How to Estimate," by *J. T. Rea*; "Specifications in Detail," by *F. W. Macey*; "Approximate Estimates," by *Colman*.

For the study of Planning, the contemporary illustrated architectural periodicals give the best help, as types keep constantly advancing with the evolution of public wants and change of opinion on the best method of meeting them.

Many of the books in these lists are costly. Students who have passed the Royal Institute of British Architects' preliminary examination have the use of the Institute's library and its loan collection of books, and a large number of the books are available at the public libraries. There is also a loan library at the Architectural Association.

Course of Study. Having stated the branches of knowledge required by an architect, and their scope, we have now to indicate the course the student is advised to pursue for acquiring them.

The old-fashioned indentured pupilage is no longer recommended, for it is now frankly admitted by most architects that it is impossible for an architect in fair practice to give any time to teaching pupils; consequently what tuition the student ever gets in an office is scant and promiscuous. In the drawing department it is largely dependent on the individual good-nature of the assistant draughtsmen, who have work of their own to do needing much concentration and generally under pressure of time. The same objection occurs in the business branch, where the secretary or clerk is still less willing to add to his duties the functions of a teacher; so that the student is generally put to



THE ROMAN ORDERS OF ARCHITECTURE
Outlines from Sir William Chambers's Treatise on Architecture

tracing plans or going on sites to hold the measuring tape, etc.—excellent things for a start, but usually continued far beyond a reasonable time for learning such simple matters. The result is that many office pupils fritter and waste away the years of their indentures, and those who do not are obliged to have recourse to evening classes and night study, which, however buoyed up by enthusiasm a youth may be, often undermines his constitution.

Day Schools in London. There are now three architectural day schools in London for students wishing to follow architecture, and they are recommended to start with one of them.

The first is at University College, Gower Street; the second, at King's College, Strand; and the third, organised by the Architectural Association at 18, Tufton Street, Westminster. The fees per year total alike—namely, 45 guineas. The course in each institution varies as to detail, but all are planned on well-considered lines which are alike in essence and in efficient thoroughness. Broadly, it consists of lectures, and the remaining time is spent in the studio or workshop.

Take, for instance, the curriculum at the Architectural Association. In the studio during the first year are taught scale and freehand drawing, the elements of perspective, the orders of architecture, the elements of architectural styles, the elements of construction, and the drawing of portions of existing buildings by measurements. The lectures are on the following subjects: (1) The historical development of architecture, illustrated by visits to buildings and museums; (2) construction and materials, illustrated by visits to workshops and buildings in progress; (3) elements of ironwork. Their object is to link the lectures with the studio work and workshop demonstrations.

The Student's Course of Reading. The student is also given a course of reading for himself, directed by the master, to whom he can at all times refer for explanations and for that aid in distinguishing between essentials and non-essentials which the tyro can never do for himself. In the studio also no time is wasted by constant repetitions of facts already learnt; and there the student gets more real supervision than can ever be given him in an office.

Time spent under these conditions also enables a teacher to find out early whether the student's talents and tastes really fit him to become an architect; so that, in the event of his incapacity, the waste of a life may be averted.

The day-school course at the Architectural Association covers two years, at the end of which time the student is advised to move into the evening continuation classes. At University College and King's College the course lasts three years. It does not follow that the student need now be indentured to an office; many never are. Some are engaged as improvers.

Office Work. But an office, except for the higher-graded assistants, is necessarily a place where one has mainly to practise what one knows quite well already. The work turned out must be expert, not tentative, and therefore, for a young man, more recapitulatory than progressive. So, although a period of office work is desirable at this stage, further outside study is necessary, and later a course at the Royal Academy School, where the artistic branches of architecture are specially studied, is much to be recommended. Eventually the student enters an office as a responsible assistant, and a man should hold this position for several years before thinking of practising for himself. To do that before he is thirty years of age is not advisable. The pitfalls in the path of a practising architect are numberless, and those who undertake the risks too soon are courting failure for life.

Opportunities in Provincial Towns. Up to now we have had in mind students living in London, and, with more or less modifications, those in leading provincial towns, such as Liverpool, where the University College provides an architectural course. Most of the large towns have architectural societies, affiliated to the Royal Institute of British Architects, whose secretaries will be pleased to give reliable directions as to the educational resources available, and as to the choice of an office for pupilage—which must be the initial procedure in places lacking other advantages.

In smaller towns the student should avail himself of the local polytechnic and art classes as best he can. In a small town, with an architect of the right sort, and one who has a practice which, though small, is general in its scope, a student often gets a good start by being in a position of more intimacy, and with more chances for working his way forward in all the branches. But he must, of course, move later to where he can obtain wider opportunities for learning.

Continued

MAMMALS IN AIR AND WATER

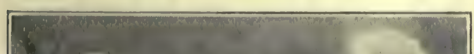
Parachuting Squirrels and Insect-eaters. Bats. Swimming Opossums. The Hippopotamus. Water Rats. The Walrus, Sea-lion, and Whales

continued from page 1871

By Professor J. R. AINSWORTH DAVIS

Parachuting Mammals. As elsewhere remarked, flying organs in their early stages of evolution were not used for the purposes of flight. In all probability they were, to begin with, "parachutes," by which climbing animals were enabled to descend from one branch or one tree to another with increasing facility. Such an endowment would be of obvious use in hunting for food, and also greatly help to baffle the attacks of climbing carnivorous enemies. Parachuting arrangements have been separately evolved in no less than three orders of mammals —*i.e.*, GNAWERS (*Rodentia*), INSECT-EATERS (*Insectivora*), and POUCHED MAMMALS (*Marsupialia*), the forms which possess them being climbers in all cases.

Flying Squirrels. Among parachuting GNAWERS the "flying" squirrels of South Asia, some of which range further north in the Old World, while others are also found in North America, are perhaps the best known types. Examination of such a squirrel [255] will show that the skin at the side of the body is drawn out into a well-marked fold, by which fore and hind limbs are united together. Smaller folds run from the fore limbs to the neck, and from the hind limbs to the base of the large bushy tail, though in some cases the latter are absent. The largest species are from 16 to 18 inches long, not reckoning the tail, which is of even greater length. When the folds are fully spread out, a very large surface is presented to the air, through which the animal is able to glide in a downward direction for nearly eighty yards. A certain amount of steering (partly by means of the tail) is said to be possible, and towards the end of a descent an upward direction may be taken if it seems desirable. In this particular group there have been at least two independent evolutions of parachuting mechanisms.

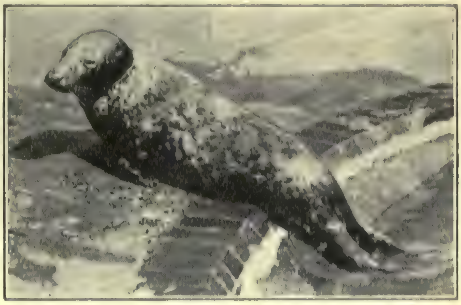


Rudland

255. FLYING SQUIRREL

The "flying" squirrels of Africa (which also possess climbing scales under the base of the tail) present similar arrangements, and there can be no question that these have been independently evolved. As in so many other cases, *e.g.*, diggers, similar conditions of life have resulted in similar adaptations answering similar purposes.

Flying "Lemurs." Among climbing INSECT-EATERS (*Insectivora*) we find one remarkable form in south-east Asia, the so-called "flying lemur" (*Galeopithecus*), which possesses well-developed parachuting membranes. Its organisation is so peculiar that it enjoys the



McClellan

256. SEAL

distinction of being placed in a sub-order all by itself, while the remaining insect-eaters are grouped together in another. One noteworthy feature is the possession of a well-marked "web" between the fingers, which increases the parachuting surface.

Some of the climbing phalangers of Australia, belonging to the order of POUCHED MAMMALS (*Marsupialia*), have also evolved parachuting folds, which have earned for them the name of "flying" phalangers.

Flying Mammals. Under this heading there is but one order, that of the BATS (*Chiroptera*), and these may be looked upon as a special branch of the climbing insect-eaters, which began by parachuting, and then gradually converted their parachutes into wings. The mechanism is a very ancient one, and unfortunately geologists are not yet in a position to throw light upon the evolutionary stages. For owing to their habits bats are but rarely preserved in the fossil state.

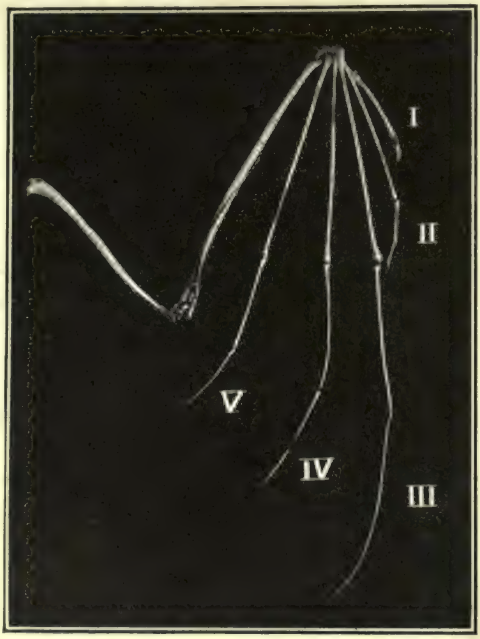
The Wings of the Bat. The flying membranes of a bat are broadly similar in extent to those of a "flying" squirrel or "flying lemur," but special features of a remarkable kind are present. It is quite clear that a wing which is to be of any service must be firmly supported,

so that appropriate muscles can bring it down with sufficient force upon the air, without undue "giving." And examination of the skeleton of a bat's wing [257] will show that this support consists of the very much elongated fingers (II. to V.), while the thumb (I.) still retains its independence, and possesses a strong hooked claw of service in climbing and scrambling.

If we imagine the fingers of the webbed hand of a "flying lemur" to gradually elongate, and the extended surface thus gained to encroach upon the ordinary parachuting fold at the side of the body, we shall get a very plausible explanation of the kind of way in which the wings of bats have gradually been brought into existence by the process of evolution.

The Muscles which Work the Wings. In bats, as in all other flying animals, the presence of wings is associated with the development of powerful muscles for moving them, and we accordingly find here that those in the chest region are very large. In order to give them a sufficiently large and firm surface for attachment, the under side of the breast-bone is provided with a prominent ridge or "keel."

As we shall see later on, the wings of Birds and of certain extinct Reptiles are constructed on two other plans, while those of Insects differ radically from all three. This well illustrates the general principle that the same biological end may be achieved by widely differing arrangements.



257. BONES OF A BAT'S WING
Photographed by Prof. B. H. Bentley

Swimming Mammals. The great majority of mammals are able to swim on occasion, for to do so it is only necessary for them to continue the movements which serve for progression on land. Man, unfortunately, is a notable exception to this. But there are members of several orders, and all those of two orders, which present special adaptations to an aquatic life. These are found in the general shape of the body, and extensions of surface for progressing in the water, as by flattening of the tail and webbing of the feet. At the same time the hairy covering is either short and dense, or it may be very greatly reduced, the eyes are small, as also are the external ears, and the nostrils are valvular.

One of the two members of the order of EGG-LAYING MAMMALS (*Monotremata*), *i.e.*, the Duck-billed Platypus (*Ornithorhynchus*), is thoroughly aquatic in habit, as may be seen by its short thick-set fur, its webbed extremities (especially the front ones), its swimming tail (flattened from above downwards), its small eyes, valvular nostrils, and entire lack of external ears [241, page 1494].

A Huge Swimmer. Among the POUCHED MAMMALS (*Marsupialia*) we find a small opossum (*Chironectes*), native to Central and South America, which feeds upon fishes, and possesses webbed hind feet as well as a long, strong swimming tail. The most notable swimmer among the HOOFED MAMMALS (*Ungulata*) is the hippopotamus [234, page 1490], in which the hair is scanty, while the four-toed feet are of sufficiently spread nature to serve as paddles. The valvular nostrils are on the top of the snout.

Some of the INSECT-EATERS (*Insectivora*) are also expert swimmers, among these being our native water-shrew (*Crossopus fodiens*), in which the hands and feet are fringed with stiff hairs which give an extension of surface. Much more highly specialised is the insectivorous otter (*Potamogale*) of West Africa, with its dense fur, small eyes, and valvular nostrils. The feet are not webbed, and the swimming organ is the powerful tail, which is compressed from side to side. Not dissimilar in some ways are the Desmans (*Myogale*) of Spain and Russia, with webbed hind feet and strong tails. GNAWERS (*Rodentia*) also add their quota to the aquatic community. The capybara (*Hydrochœrus*) of South America, for instance, the largest living member of the order, possesses partially webbed feet, while our native water-rat, or rather water-vole (*Microtus amphibius*), is an expert swimmer, although its feet are not webbed. The hind limbs are the active agents of progression.

Aquatic Flesh-eaters. From the forms already mentioned we pass to others, a remarkable series of which belong to the FLESH-EATERS (*Carnivora*). The otter (*Lutra*), with its webbed feet, powerful swimming tail, and small ears, is a case in point. The rare sea-otter (*Enhydris*) of the North Pacific is constructed on somewhat similar lines. One entire subdivision of the order (*Pinnipedia*), contains aquatic animals only. All are distinguished by the possession of a thick coat of fat (blubber) beneath the skin, which is intelligible if we

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259. PORPOISE

remember the cold regions in which they mostly live. The huge walrus (*Trichechus*) possesses paddle-like limbs, and its hair is very scanty. The sea-lions (*Otaria*) are somewhat more specialised on the same lines, except that, like ordinary seals, their fur is extremely close-set. These forms are also called "eared seals" because they still possess small external ears. In both walrus and sea-lion the hind flippers can be turned forwards to assist in a shuffling kind of progression on land or ice, while the former uses its tusks to some extent to help itself along in rough places. From these we pass on to the true seals (*Phoca*, etc.), in which the hind flippers are directed backwards, and bound up by folds of skin with the short tail [**256**], to constitute a very powerful paddle. This specialisation, though admirable for swimming purposes is, of course, a hindrance to progression on land, over which the true seals make their way by what may be described as a mixture of crawling and springing.

Freshwater Seals. But little is known of the remote ancestry of Pinnipedes, but one of the ancient flesh-eaters (*Creodonta*), native to North America, possessed somewhat seal-like extremities. This creature (*Patriofelis*), was a lake-dweller, and appears to have lived upon freshwater tortoises. It is, therefore, not unlikely that seals and their allies were first evolved in fresh water, from which they ultimately made their way into the open ocean. Seals are now found in some inland seas—*e.g.*, the Caspian, Sea of Aral, and Lake Baikal; but this has a different significance, for we know that in comparatively recent geological

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258. MANATEE

times these bodies of water have been cut off from the main ocean of which they once formed a part.

An interesting parallel is afforded by Lake Tanganyika, which is inhabited not only by ordinary freshwater forms, but also by jellyfishes, certain molluscs, etc., which are characteristically marine. We may regard the lake, in fact, as a separated part of the Indian Ocean.

The Manatee. The order of SEA-COWS (*Sirenia*) includes only the manatee [**258**] and the dugong, both of which are purely aquatic. The fore limbs are flippers, and the absence of hind limbs is compensated for by the broadening out of the tail in a horizontal direction. The hair is very scanty, the valvular nostrils are on the top of the snout, and external ears are entirely absent. There is a thick layer of blubber. The tail of the manatee is rounded, while that of the dugong is produced into a pointed "fluke" on either side as in whales and their allies.

Mammals that Resemble Fishes. We come lastly to the WHALES AND PORPOISES (*Cetacea*), which are still more perfectly adapted to an aquatic life. We note in a porpoise [**259**], for example, the fish-like shape, well adapted for rapid progression through the water, and the smooth, practically hairless skin (beneath which is a thick layer of blubber). The fore limbs are flippers and the broad tail is horizontally flattened (only the edge can be seen in the figure), being shaped like that of a fish except that it is not vertical. Hind limbs and external ears are entirely absent, and the eyes are small. The nostrils of Cetaceans are represented by a single or double "blow-hole," of valvular nature, right on the top of the head, an obvious convenience for breathing air with most of the body submerged. The "spout" which issues from the blow-hole is not a column of water, as often erroneously supposed, but the chilled and condensed vapour of the expired air.

Origin of Marine Mammals. There can be no doubt that Cetaceans are the much modified descendants of land animals which have wrested the sovereignty of the sea from marine reptiles now long extinct. Unfortunately the geological record has not, so far, supplied us with the evolutionary stages of this ancient group, and all that can be definitely asserted is that the oldest types are in some anatomical features rather nearer land mammals than those existing at the present day. But it is a matter of opinion whether they are more closely allied to Hoofed Mammals or Flesh-eaters Most probably all three groups have descended from the same immensely ancient primeval stock, of which at present we have no certain knowledge.

Continued

Continued from page 188)

SPANISH—ITALIAN—FRENCH—GERMAN

Spanish by Mme. de Alberti; Italian by F. de Feo; French by Louis A. Barbé, B.A.; German by P. G. Konody and Dr. Osten

SPANISH

By Mme. de Alberti

THE Spanish alphabet is composed of twenty-eight letters pronounced as follows:

A	.. ah	I	.. ee	Q	.. coo
B	.. bay	J	.. hota	R	.. air-ay
C	.. thay	K	.. cah	S	.. essay
CH	.. tchay	L	.. el-lay	T	.. tay
D	.. day	LL	.. el-lyay	U	.. oo
E	.. a	M	.. em-ay	V	.. vay
F	.. ef-fay	N	.. en-ay	X	.. a-kis
G	.. hay	Ñ	.. en-nyay	Y	.. e-griega
H	.. ah-tchay	O	.. oh	Z	.. thay-tah
		P	.. pay		

These letters are of the feminine gender, and are divided into vowels and consonants, as in English.

Pronunciation. The Spanish vowel sounds do not vary, and must be pronounced fully and distinctly. The *u* is silent in the syllables *gue, gui*; *que, qui*, which are pronounced *gay, gee*; *kay, key.* When the *u* is to be sounded, it is marked thus, *ü*; as in *argüir*, to argue, which is pronounced *argooeer.*

Y is used both as a vowel and a consonant; alone, after a vowel and followed by a consonant; or, at the end of a word, it is a vowel and is sounded as *ee* in English. Before a vowel in the same syllable, or between two vowels in the same word, it is a consonant, and is sounded like the English *y* in *yours.*

C is pronounced hard before *a, o, u, l*, and *r*; ex., *cabra*, goat; *cola*, tail; *cuero*, hide; *claro*, clear; *crudo*, raw; which are pronounced *kabra, kola, kuero, klaro, krudo.* It is soft before *e* and *i*: ex., *cera*, wax; *cien*, a hundred; pronounced *thera, thien.*

CH, D, and F have the same sound as in English.

G, before *a, o,* and *u*, has the same sound as in English. Before *e* and *i* it is a guttural aspirate, like the English *h* very strongly aspirated: ex., *general* (general) pronounced *hénéral.*

H is never aspirated.

J has always the same guttural sound as *g* before *e* and *i*; it can only be rendered in English by the strongly aspirated *h.*

K is not used in modern Spanish; in the few words in which it used to appear its place is now supplied by *c* before *a, o,* and *u*, and by *qu* before *e* and *i.*

L has the same sound as in English.

LL, which is counted as a separate letter, can only be rendered in English by a combination of *l* and *y*, somewhat like *li* in vermilion: ex., *llorar* (to weep), pronounced *lyorar.*

M has the same sound as in English; it is never doubled in Spanish.

N has the same sound as in English. In words in which *gn* occur, both letters are distinctly sounded: ex., *dignidad* (dignity) is pronounced *dig-nidad.*

Ñ has a strong nasal sound, which is only approached in English by the *n* in poniard.

P has the same sound as in English.

Q is invariably followed by *u*; the two letters together, *qu*, are sounded like an English *k.*

R, at the beginning of a word, is pronounced like *rr*: ex., *rabia* (rage), *ruido* (noise); pronounced *rrabia, rrooido.* In the middle of a word it is sounded like the English *r.* When *rr* occurs it must be very strongly marked.

S is always pronounced *ss*: ex., *paseo* (a walk), pronounced *pas-say-o.* The final *s* is always very soft.

T has the same sound as in English; it is never doubled in Spanish.

V has the same sound as in English. Spaniards sometimes pronounce it *B*, but the practice is not encouraged by the Spanish Academy.

X has the sound of *gs*: ex., *exhalar* (to exhale), pronounced *egssalar.* In all words in which *x* was formerly a guttural aspirate it is now superseded by *j.* The most notable example is the name of *Don Quixote*, pronounced *Key-hot-ay*, which is now spelt *Quijote.*

Z is pronounced *th*, like the soft *c*: ex., *cruz* (cross), pronounced *kruth.*

The Accent, There is only one accent in Spanish, which is placed over the vowels *á, é, í, ó, ú.* It lengthens the syllable over which it is placed, so that the stress is laid upon it, and the rest are pronounced short: ex., *águila* (eagle), pronounced *á-guila*; *acá* (here), pronounced *a-cá.* It also distinguishes words which are spelt the same: ex. *el* (the), *él* (he).

Parts of Speech. There are ten parts of speech. The variable — *viz.*: article, noun, adjective, pronoun, verb, participle; and the invariable—*viz.*: adverb, preposition, conjunction, interjection.

Gender. There are three genders: masculine, feminine, and neuter. The neuter gender is never applied to persons or things, but only to adjectives, pronouns, etc., used to convey a substantive idea in a general or abstract manner: ex., *lo malo*, the evil, or all that is evil; *lo bueno*, the good, or all that is good); *lo mío*, mine, or all that is mine. The neuter gender has no plural.

Numbers. There are two numbers: the singular and the plural.

Punctuation. The use of punctuation marks differs from the English in two particulars. The mark of interrogation is placed at the beginning of a sentence, below the line (¿), and is repeated above the line at the end (?).

The mark of exclamation is also placed below the line (¡) at the beginning of the sentence, and is repeated above the line at the end (!).

Vocabulary	Vocabulario
God	Dios
The stars	Los astros
A comet	Un cometa
A star	Una estrella
The polar star	La estrella polar
The firmament	El firmamento
The moon	La luna
The moonlight	El resplendor de la luna
The new moon	La luna nueva
The full moon	La luna llena
The first quarter	El cuarto creciente
The last quarter	El cuarto menguante
The sun	El sol
Sunrise	La salida del sol

THE SEASONS.

Spring	La primavera	Autumn	El otoño
Summer	El verano	Winter	El invierno

THE MONTHS.

January	Enero	July	Julio
February	Febrero	August	Agosto
March	Marzo	September	Septiembre
April	Abril	October	Octubre
May	Mayo	November	Noviembre
June	Junio	December	Diciembre

THE DAYS.

Sunday	Domingo	Wednesday	Miércoles
Monday	Lúnes	Thursday	Jueves
Tuesday	Martes	Friday	Viernes
Saturday	Sábado		

A child	Un niño
A boy	Un muchacho
A man	Un hombre
A young man	Un jóven
Young men	Los jóvenes
A girl	Una niña
A young girl	Una muchacha, una jóven
A woman	Una mujer
An old man	Un anciano
A bachelor	Un soltero
A married man	Un casado
A married woman	Una casada
A widower	Un viudo
A widow	Una viuda
Infancy, childhood	La infancia, niñez
Youth	La juventud
Adolescence	La adolescencia
Manhood	La edad viril
Old age	La vejez
Death	La muerte
Business	Los negocios
The future	El porvenir
Happiness	La dicha
A career	Una carrera
The town, city	La ciudad
The citizen	El ciudadano
The expense	El gasto
The residence, dwelling	El domicilio
Education	La educacion
A funeral	Un entierro
Savings bank	Caja de ahorros
A habit	Una costumbre
An inheritance	Una herencia
An heir	Un heredero
An invention	Una invencion
A legacy	Un legado
Of age, having attained majority	Mayor de edad
Misfortune	La desgracia
Marriage	El matrimonio
Misery	La miseria
The present	El presente
The past	El pasado
The future	El futuro
The native country	La patria
Poverty	La pobreza
A profession	Una profesion
Punishment	El castigo
Reward	La recompensa
Reputation	La reputacion
Wealth	La riqueza
Society	La sociedad
A co-operative society	Una sociedad co-operativa
A syndicate	Un sindicato
Work	El trabajo
A guardian	Un tutor
The family	La familia
Father	Padre
Mother	Madre
The son	El hijo
The daughter	La hija
The brother	El hermano
The sister	La hermana
The grandson	El nieto
The granddaughter	La nieta
The husband	El marido
The wife	La mujer, also esposa
The father-in-law	El suegro
The mother-in-law	La suegra
The brother-in-law	El cuñado
The sister-in-law	La cuñada
A bastard	Un bastardo

Articles

El—masculine singular	La—feminine singular
Los—masculine plural	Las—feminine plural

EXERCISE I.

Translate the following into Spanish:

1. The stars, the comets, and the moon shine in the firmament.
   brillan en
2. Nothing more beautiful than moonlight.
   Nada más que
3. Few have seen the sunrise.
   Pocos han visto
4. Spring is the most agreeable time of the year; summer is too hot.
   es tiempo más agradable del año demasiado caluroso.
   The colours of the autumn are picturesque.
   colores son pictorescos.
   Winter does not please everyone.
   no agrada á todos.

5. A boy must pass through childhood and
debe pasar por
adolescence before he is (a) man.
antes de ser
6. Old age is the precursor of death.
precursor de
7. (It) is a happiness that the future is
que nos
unknown to us.
sea desconocido.
8. Man is not of age until twenty-one.
no hasta (los) veinte y un (años).
9. Misery is cruel.
cruél.
10. The expense of education is great.
grande

NOTE. The article must be inserted before the nouns whenever these are given in the vocabulary. Practice will soon teach where the article is required in Spanish. Keys to Exercises are given in the succeeding lessons.

PROSE EXTRACT I.

[From the chronicle of the reign of Peter the Cruel. By Pedro Lopez de Ayala.]

Peter the Cruel and the Prince of Wales (the Black Prince) after the battle of Najera.

———

The Prince of Wales said to the king, Don Pedro, that, saving his Royal Majesty, neither his words nor his demands were in reason; for those knights and men-at-arms, who were there in his service, had striven for honour's sake; and if they had taken any prisoners they were their own; and the knights who held them were such, that not for any money in the world, though it were a thousand times the value of the prisoners they held, would they deliver them to him, for they would think that he redeemed them to put them to death: and that he should urge it no more, for it was not a thing which he could grant. However, if there were any among the prisoners upon whom he had passed sentence before this battle, he would cause them to be delivered to him.

Then the king, Don Pedro, said to the Prince that if these things were to fall out so, he deemed his kingdom more lost than it was at first, for it was those very prisoners who had caused him to lose the kingdom, and since they were to escape thus, and not to be delivered up to him that he might come to an agreement with them and win them to his cause, he made but small account of the Prince's help, and deemed that he had spent his treasures in vain. Then the Prince was enraged at these words which the king, Don Pedro, had spoken to him, and he answered in this fashion: "Sir kinsman, it seems to me that you have now stronger means to recover your kingdom than you had when it was in your possession and you governed it in such a manner that you were like to lose it. And I would counsel you to cease this putting to death, and to seek some means of recovering the good-will of the lords and knights and noblemen, and of the cities and towns of this your kingdom; for if you do otherwise, and behave yourself as you did before, you stand in great peril of losing both your kingdom and yourself, and of being brought to such a pass that neither my lord and father the king of England, nor myself, shall be able to avail you aught, although we should be so minded." And these things thus passed between the king, Don Pedro, and the Prince upon that day, Sunday, after the battle as they lay there in camp.

———

Pedro Lopez de Ayala (1332-1407), poet, Court chronicler, and Chancellor of Spain.

Don Pedro el Cruél y el Principe de Gales despues de la batalla de Nájara.

———

El Principe de Gales dijo al Rey Don Pedro que salve su Real Majestad no decía, ni pedía razon; que aquellos Señores Caballeros y hombres de armas que alli eran en su servicio habian trabajado por la honra, y si algunos prisioneros habian eran suyos, y que tales eran los caballeros que los tenian que por dinero del mundo aunque fuesen mil tantos que valíese el prisionero que tuviesen que no le rendirian á él, por cuanto pensarian que los cobraba para los matar: que en esto no se trabajase, que no era cosa que él pudiese librar. Empero si tales caballeros fuesen presos, contra los cuales él pasára sentencia antes de esta batalla, que él se los haría entregar.

Entonces dijo el Rey Don Pedro al Principe, que si estas cosas así habían de pasar que mas perdido tenía ahora el Reino que le tenía primeramente: que todos aquellos que eran presos eran los que le habían hecho perder el Reino, y que pues aquellos asi habían de escapar y no ser entregados á él para traer con ellos sus pleitesias para que quedasen suyos, que no hacía cuenta que le había ayudado el Principe; mas tenía que gastára sus tesoros de balde. Y entonces fué sañudo el Principe por estas razones que el Rey Don Pedro así le dijo, y respondiole de esta manera: "Señor pariente, á mí me parece que vos teneis maneras mas fuertes ahora para cobrar vuestro Reino que tuvistes cuando teniais vuestro Reino en posesion, y le registeis en tal guisa que le tuvisteis que perder. Y yó os aconsejaria de cesar de hacer estas muertes, y que buscáse manera de cobrar las voluntades de los señores y caballeros, y hidalgos, y ciudades, y pueblos de este vuestro Reino, y si de otra manera vos gobernais segun primero lo hicisteis, estais en gran peligro de perder vuestro Reyno, y vuestra persona, ý llegarlo á tal estado, que mi señor y padre el Rey de Inglaterra, ni yo aunque quisiésemos no os podriamos valer." Y así pasaron estas razones entre el Rey Don Pedro, y el Principe aquel dia Domingo despues de la batalla que estuvieron allí en el campo.

———

Pedro Lopez de Ayala (1332-1407) poeta, cronista de la corte y canciller de España.

He was taken prisoner at the battle of Najera and brought to England, where he wrote some of his poems. He describes the events of the four reigns in which he lived with the knowledge of an eye-witness. His chronicles are the first attempt at serious history in Spanish. The spelling of the above extract has been modernised for the convenience of our students.	Fué hecho prisionero en la batalla de Nájara y llevado á Inglaterra donde escribió algunos de sus poemas. Describió los acontecimientos de los cuatro reinados durante los cuáles vivió, con el saber de un testigo ocular. Sus crónicas son el primer atento serio á una historia de España. La ortografía del extracto que antecede ha sido modernizada para la conveniencia de nuestros estudiantes.

PHONETIC RENDERING OF THE EXTRACT.

The following is a phonetic rendering of the pronunciation of the extract:

El Printheepay day Gah-les dee-ho al ray Don Paydro kay salvay soo rayal mah-hestah, no daythea nee paydeea rahthon; kay ah-kellyos say-nyores, cah-ballyerohs, ee ombrays day armahs, kay allyee airan en soo sairveetheo ah-beean trahbah-hado por lah onrah, ee see algoo-nohs preseonerohs ah-beean airan soo-yohs, ee kay tah-les airan loss cah-ballyerohs kay loss ten-eean kay por deenero dell moondo ahoonkay fooaysen mill tan-tohs kay vah-lee-essay el preseonero kay toovee-essen kay no lay rendeereean ah el por cooanto pensah-reean kay los kobrah-ba pahra loss mah-tar: kay en essto no say trahbah-ha-say, kay no airah kossa kay el poodee-essay lee-brar. Empairo see tah-les cah-ballyeros fooay-sen pres-ohs kontra loss koo-ales el pahsah-ra sententhia antes day esta bah-tallyah, kay el say loss ah-reea entre-gar.

Enton-thes dee-ho el ray Don Paydro al printheepay, kay see esstahs kossas ahsee ahbeean day pahsar; kay mas pairdeedo tayneea ahorah el rayno kay lay tayneea pree-mairamentay: kay toe-does ah-kellyos kay airan pres-ohs airan loss kay lay ahbeean aycho pairdair el rayno, ee kay pooes ah-kellyos ahsee ahbeean day es-kapar ee no sair entray-gahdohs ah el pahra trah-air kon ellyos soos playtayseeas pahra kay kaydahsen soo-yohs, kay no ahseea cooenta kay lay ahbeea ah-yudado el printheepay; mas tayneea kay gastah-ra soos taysoros day balday. Ee en-tonthes fooay sah-nyoodo el printheepay por esstahs rahthon-es kay el ray Don Paydro ahsee lay dee-ho, ee respondeeolay day esstah maner-ah: "Saynyor par-e-entay ah mee may parethay kay vos tay-nayis manerahs mas fooer-tes ahorah pahra kobrar vooestro rayno, kay toovistes cooando tayneeah-is vooestro rayno en pos-ses-seon ee lay ray-histayis en tal geesa kay lay toovistayis kay pairdair. Ee yo os ahconsay-hareea day thesar day ah-ther esstahs mooert-es, ee kay boos-kahsay manerah day kobrar las voloontades day loss saynyores, ee cah-ballyerohs, ee eedalgoes, ee thie-ooda-des ee pooayblohs day esstay vooestro rayno, ee see day ohtra manerah vos gobairnah-is saygoon preemairo lo heeceestayis, essta-is en gran payleegro day pairdair vooestro rayno, ee vooestro pairsohna, y day lyaygarlo a tal esstahdo, kay mee saynyor ee pahdray el ray day Inglah-terrah nee yo ahoonkay kiseeaymos no os podreeahmos vahlair. Ee ah-see pahsah-ron esstahs rathone-es entray el ray Don Paydro, ee el printheepay ah-kel deea Doh-mingo despooes day la bah-tallyah kay esstoo-vee-airon allyee en el campo.

Continued

ITALIAN — By Francesco de Feo

THE Italian alphabet (*alfabeto*, or, from the name of the first three letters of the Italian alphabet, *abbiccì*) consists of the following 21 letters pronounced as follows:

A .. ah	H .. àhckah	Q .. koo
B .. bee	I .. ee	R .. èhrreh
C .. chee	L .. ehlleh	S .. èhsseh
D .. dee	M .. ehmmeh	T .. tee
E .. eh	N .. ehnneh	U .. oo
F .. èhffeh	O .. o	V .. vee
G .. dgee	P .. pee	Z .. dzèhtah

The letters *k*, *j*, *x*, *y*, *w* do not occur in Italian. *X* and *y* are used in mathematics to indicate an unknown quantity. *X* is also met with in the Latin *ex* (ehx) in compound words like *ex-deputato* (ex M.P.), *ex-direttore* (ex-director).

Vowels and their Pronunciation. A is always pronounced open and broad, like English ah! The student should pronounce the exclamation ah! the English bah, and then the Italian *la* (the, fem.), *ma* (but). After this he will find it easy to connect the same vowel sound with other consonants. In pronunciation this sound will be represented by *ah*, as *amare* (ahmàhreh), to love.

E is never mute in Italian. It has two sounds: closed, like *ai* in pain, as *venti* (véhntee), twenty; open, like *e* in let, as *vènti* (vèhntee), winds. These sounds will be represented by *eh*: *crèdere* (crèh-deh-reh), to believe.

I is not sounded as the English *i* in Italy, it, kiss. This sound will be represented by *ee*: *brìndisi* (brèen-dee-see), toast.

O, like *e*, has two sounds: closed, like *o* in note, as *voce* (vòcheh), voice; open, like *o* in not, as *còrpo* (body).

U is always pronounced like *oo* in cool, as *punire* (poonèereh), to punish. This sound will be represented by *oo*.

The distinction between the open and closed sounds of *e* and *o* offers some difficulty to Italians themselves, so that foreigners need not be too particular about it. Those who have a knowledge of Latin will find assistance from the following hints:

1. **E** is closed when it replaces (*a*) a Latin long *ē*: mē, tē, fēci; (*b*) a Latin short *ĭ*: fĭdem, *féde*; nĭve (*m*), *néve*. The Latin long *ī* remains in Italian: infidu (m), *infido*.

2. **E** is generally open when it replaces a Latin short *ĕ*: pĕde (m), *piede*.

1. **O** is closed when it replaces (*a*) a Latin long *ō*: corōna, *corona*; (*b*) a Latin short *ŭ*: crŭce (m), *croce*.

2. **O** is generally open when it replaces a Latin short *ŏ*: hŏmo, *uòmo*; or a Latin *au*: *aurum*, *òro*. It has also the open sound when it is preceded by *i* or *u*: *piòve*, it rains; *cuòre*, heart; and before an *s* in substantives, as *ròsa*, *rose*; *spòsa*, spouse.

Diphthongs. In Italian, real diphthongs do not exist. Every vowel must be separately and distinctly pronounced. In words where the combinations *uo*, *ia*, *ie*, *io*, *iu* are found the *u* and *i* must be pronounced short: *buono* (boo-òno), good; *pieno* (pee-èhno), full; *più* (pee-oò), more.

Accent. In the Italian orthography, the accent is not shown, except when it falls on the last vowel of a word, when it is used either to mark a contraction, as in *virtù* (veer-toò) for *virtute*, or a verbal termination, as in *farò*, *dirò*. It is also used to distinguish the pronunciation of words spelt alike, but having a different accent and meaning. For example: *àncora*, anchor; *ancòra*, yet.

As a general rule, we may assume that the tonic accent or stress in Italian is laid on the last syllable but one. Whenever there is a deviation from this rule it will be here indicated by a grave accent, to show on which vowel the stress must be laid: *pàrlano* (pàhr-lah-no), they speak.

Apostrophe. The apostrophe is used to show the omission of a vowel, and, in some cases, of a syllable. For example: *l'uso* (loòso), the custom; *un po'* (oon po) a little, for *un poco*.

Exercise I.

On Reading the Vowels: *pane* (bread), *carne* (meat), *bene* (well), *cane* (dog), *capo* (head), *sera* (evening), *giorno* (day), *mattina* (morning), *libro* (book), *carta* (paper), *penna* (pen), *tàvola* (table), *amico* (friend), *fratello* (brother), *sorella* (sister), *zio* (uncle), *cappello* (hat), *capelli* (hair), *vino* (wine), *fiume* (river), *fumo* (smoke), *buono* (good), *cattivo* (bad), *piede* (foot), *dieci* (ten).

Pronunciation of the above Words: Pàh-neh, càhr-neh, bèh-neh, càh-neh, càhpo, sèhrah, dgeeòrno, mahtteè-nah, leèbro, càhr-tah, pèhnnah, tàhvolah, ahmeèco, frah-tèhllo, sorèhllah, tseè-o, cahppèhllo, cahpèhllee, veèno, fee-òomeh, foomo, boo-òno, cahtteèvo, pee-èh-deh, dee-èh-chee.

Consonants and their Pronunciation. The consonants in Italian are sounded as in English, with the following exceptions:

C before *e* or *i* is sounded as the English ch in cherry, chin: *Cèsare* (chèh-sah-reh), Cæsar; *città* (cheettàh), town; *cibo* (cheébo), food. **Ch** is sounded as *k*; *chi?* (kee) who? *perchè* (pehrkèh), because.

G before *e* or *i* is sounded as the English *g* in geography, gin: *gente* (dgèhn-teh), people; *Tamigi* (tahmeè-dgee), Thames.

Gh is sounded as the English *g* in get, give: *botteghe* (bottèhgheh), shops; *ghinea* (gheenèh-ah), guinea.

Gli before a vowel, or at the end of a word, is pronounced like the *lli* in billiards, as: *bottiglia* (botteèleeah), bottle; *figlio*, (feèleo), son.

Gn is sounded as *ni* in minion: *montagna* (montàh-neeah), mountain; *ogni* (*ònee-ee*), every.

H is not pronounced; *hanno* (ahnno), they have.

S, Z have two sounds: hard, *cosa*, *zampa*; soft, *uso*, *zolla*.

Sce, Sci are sounded as *sh* in shell, ship: *scena* (shèhnah), scene; *scienza* (shèhndzah), science.

Sch is sounded as *sk*: *schioppo* (skeeòppo), gun.

When two consonants (*mm*, *nn*, *tt*, etc.) come together, they must be both pronounced: *carro* (cart), *caro* (dear); *penna* (pen), *pena* (pain); *fatto* (fact), *fato* (fate).

Exercise II.

On Pronunciation. *Quel*, that; *questo*, this; *quasi*, almost; *mezzogiorno*, south: *òcchio*, eye; *ricomincia*, begins again; *ripigliar*, to retake; *lasciare*, to let: *cocùzzolo*, top (of a mountain); *esempio*, example; *mura*, walls; *guàrdano*, they look; *più*, more; *giogaia*, ridge; *oscuro*, dark *due*, two: *a destra*, on the right.

Pronounced: Koo-èhl, koo-èh-sto, koo-àhsee, meh-dzo-dgee-òrno, òckeeo, ree-comeén-chah, ree-peè-lee-ar, làh-shah-re, cokoòt-solo, ehsèmpeeo, moorah, guàhrdahno, dgeeo-gàh-eeah, oskoòro, doòeh, ah deh-strah.

Exercise III.

Quel ramo del lago di Como, che volge a mezzo-giorno, tra due catene non interrotte di monti, tutto a seni e a golfi, a seconda dello spòrgere e del rientrare di quelli, vien, quasi a un tratto, a restrìngersi e a prender corso e figura di fiume, tra un promontòrio a destra e un' àmpia costiera dall' altra parte; e il ponte, che ivi congiunge le due rive, par che renda ancòr più sensìbile all' occhio questa trasformazione, e segni il punto in cui il lago cessa, e l'Adda ricomìncia, per ripigliar poi nome di lago dove le rive, allonta—nàndosi di nuovo, lascian l'acqua distèndersi e rallentarsi in nuovi golfi e in nuovi seni. La costiera, formata dal depòsito di tre grossi torrenti, scende appoggiata a due monti contigui, l'uno detto di San Martino, l'altro con voce lombarda il Resegone, dai molti suoi cocùzzoli in fila, che in vero lo fanno somigliare a una sega: talchè non è chi, al primo vederlo, purchè sia di fronte, come per esèmpio di su le mura di Milano che guàrdano a settentrione, non lo discerna tosto, a un tal contrassegno, in quella lunga e vasta giogaia, dagli altri monti di nome più oscuro e di forma più comune.

The Article. As in English, there are two articles in Italian—*definite* and *indefinite*.

Definite Article (The) Masculine: *il*, *lo*, *l'*, for singular; *i*, *gli*, for the plural;

Feminine: *la*, *l'*, for the singular; *le*, for the plural.

Indefinite Article (A, An). Masculine: *un*, *uno*. Feminine: *una*.

Il is used before masculine nouns beginning with a consonant or consonants, except *z*, impure *s* (*s* followed by one or two consonants, as: *sp*, *spr*, *sc*, *scr*, *sch*, etc.), and *gn*, as: *il cane*, the dog; *il libro*, the book; *il braccio*, the arm.

Lo is used instead of *il* before *z*, impure *s*, *gn*, as: *lo zio*, the uncle; *lo scolaro*, the pupil; *lo gnomo*, the gnome.

L' is used before masculine and feminine nouns beginning with a vowel, as *l'onore*, the honour; *l'uomo*, the man; *l'oro*, the gold; *l'anima*, the soul; *l'arte*, the art. *Le* drops the *e*, and is written *l'* only before an *e*, as: *l'erbe*, the herbs; but *le opere*, and not *l'opere*.

I, Gli. When *il* is used in the singular, *i* is used in the plural, as: *i cani*, *i libri*. When *lo* is used in the singular, *gli* is used in the plural, as: *gli zii*, *gli onori*. The *i* in *gli* is dropped, and an apostrophe is put instead only before nouns beginning with an *i*, as *gl'inni*.

Un is used as the article *il*, and before a vowel, as: *un libro*, a book; *un ragazzo*, a boy; *un amico*, a friend.

Uno is used in the same cases as *lo*, as: *uno zio*, *uno scultore*, *uno gnocco* (oono nee-òcco), a little dumpling.

Una is written *un'* before a vowel, as *un' anima; un' abitudine*, a habit.

Masculine Nouns

libro (leèbro) book.
uccello (oochèhllo), bird.
amico (ahmeèco), friend.
scolaro (skolàhro), pupil.
coltello (koltèhllo), knife.
temperino (tehmpehreèno), pen-knife.
ragazzo (rahgàh-tso), boy.
scultore (skool-tòreh), sculptor.
cavallo (cahvàhllo), horse.
zio (tseèo), uncle.

Feminine Nouns

penna (pèhnnah), pen.
rosa (ròsah), rose.
casa (càhsah), house.
busta (boòstah), envelope.
carrozza (kahrròtzah), carriage.
figlia (feè-leeah), daughter.
stàtua (stàhtooah), statue.
spàzzola (spàtzolah), brush.
sorella (sorèhllah), sister.

To form the plural of these nouns, change the terminations *o* into *i*, and *a* into *e*, as: libro, libri; cavallo, cavalli; rosa, rose; casa, case.

e (before e, *ed*) and; *o* (before o, *od*) or.

Io ho (eè-o òh), I have.
tu hai (too àhee), thou hast.
egli ha (èh-lee ah), he has.
noi abbiamo (nòee ahbbeeàhmo), we have.
voi avete (vòee ahvèhte), you have.
essi hanno (ehssee àhnno), they have.

Exercise IV.

1. L'amico. Io ho un amico. Tu hai una rosa. Egli ha una figlia. Noi abbiamo una casa. Il ragazzo ha una penna. Lo scultore ha una statua. Lo zio ha una spazzola. Lo scolaro ha un libro e una penna. Voi avete una sorella. Essi hanno un cavallo e una carrozza.

2. I ragazzi hanno un coltello e un temperino. Voi avete le buste e le penne. Gli scolari hanno le buste e i libri. Gli scultori hanno le statue. Gli zii hanno le case. Il ragazzo ha le rose. Gli amici hanno gli uccelli, i cavalli e le carrozze.

Some Prepositions

Di (before a vowel *d'*) of; *di Pietro*, of Peter; *d'onore*, of honour.

A (before a, *ad*) to; *a Londra*, to London; *ad Andrea*, to Andrew.

Da, from (after the passive verb, by); *da Roma* from Rome; *da me*, by me.

In, in, into; *in Germania*, in Germany.

Con, with; *con amore*, with love.

Su, on, upon; *su domanda*, on demand.

Per, for; *per voi*, for you.

These prepositions (especially *di*, *a*, *da*, *in*) when they occur with the article, are contracted into one word. For the contraction, change *di* into *de*, and *in* into *ne*.

Of the: *di il* (*de l*) *del*; *di la* (*de la*) *della*; *di lo* (*de lo*) *dello*; *di i* (*de i*) *dei*; *di gli* (*de gli*) *degli*, etc. (pronounced dehl, dehlla, dehllo, deh-ee, dèh-lee-ee).

To the: *a il* (*a l*) *al*; *a la*, *alla*; *a lo*, *allo*; *a i*, *al*, etc.; (pronounced, ahl, àhllah, àhllo, àhee).

From the: *da il* (*da l*) *dal*; *da la*, *dalla*; *da lo*, *dallo*; *da i*, *dai*, etc.; (pronounced dahl, dàhllah, dàhllo, dàhee).

In the: *in il* (*ne l*) *nel*; *in la* (*ne la*) *nella*; *in lo* (*ne lo*) *nello*; *in i* (*ne i*) *nei*; *in gli* (*ne gli*) *negli*; (pronounced nehl, nèhllah, nèhllo, nèh-ee, nèh-lee-ee).

Some modern authors write also *de la*, *da le*, *de gli*, *da gli*, *ne la*, *a la*, etc., in two words. *Con*, *su*, and *per* are also contracted, but only with *il* and *i*, as *col*, *coi* (coèe), *sul* (sool), *sui* (soò-ee), *pel* (pehl), *pei* (pèh-ee).

Note. The compound articles follow the same rules as the corresponding uncontracted articles, *del padre*, *dello zio*, *dello scultore*, *dell'ora*, *delle parole*, *degli zii*, etc.

Masculine Nouns

danaro (dahnàhro), money.
giardino (dgeeàhr-deéno), garden.
regalo (rehgàhlo), present.
mèdico (mèhdeeco), physician.
signore (seeneeòreh), gentleman.
anello (ahnèhllo), ring.

Feminine Nouns

lèttera (lèhttehrah), letter.
seta (sèhtah), silk.
stanza (stàhndzah), room.
signora (seeneeòrah), lady.
Londra (Lòndrah), London.
Parigi (Pahreèdgee), Paris.

Sono, they are; *avuto* (ahvoòto), had; *ricevuto* (reechehvoòto), received; *comprato,* bought.

EXERCISE V

ON THE COMPOUND ARTICLES. Un cappello di seta. La statua dello scultore. Il medico di casa. La busta della lettera. Noi abbiamo ricevuto una lettera da Parigi. Da Londra a Parigi e da Parigi a Roma. I libri degli scolari sono su la tavola. Il signore e la signora sòno nel giardino dello scultore. I ragazzi hanno ricevuto un regalo. La figlia del medico ha ricevuto un anello d'oro. Gli amici hanno comprato una casa col danaro ricevuto da Roma. Le lettere per la signora sono su la tavola nella stanza dei ragazzi.

Partitive Article. The partitive sense expressed in English by *some* or *any* is expressed in Italian by the preposition *di,* either simple or contracted with the definite article, thus: *del pane,* some bread; *uno di voi,* one of you; *avete del vino?* have you any wine?

The partitive sign is omitted:

(1) In negative sentences. *Io non ho amici,* I have no friends.

(2) When the noun is preceded by an adverb of quantity. *Avete molto danaro?* have you much money?

(3) When the noun is taken in a general sense. *Egli ha cavalli e carrozze,* he has horses and carriages.

EXERCISE VI.

ON THE PARTITIVE ARTICLE. Dei cavalli per le carrozze. Delle rose nel giardino. Le signore hanno delle rose. Noi abbiamo ricevuto dei regali. Il ragazzo ha avuto dei libri. Egli ha comprato delle buste e delle penne per degli scolari. Hanno essi molti cavalli? Le signore hanno ricevuto delle lettere da Parigi. Lo scultore ha avuto cavalli, carrozze case e giardini.

Io sono, I am; *noi siamo* (seeàhmo), we are; *tu sei* (sèh-ee), thou art; *voi siete* (see-èhteh), you are; *egli è* (èh), he is; *essi sono,* they are.

Non, not, is placed before the verb, as: *io non ho* (I not have), I have not; *io non sono* (I not am), I am not.

In interrogative phrases, the personal pronouns may be placed after the verb (*hanno essi?*), but they are nearly always omitted, as the different persons are sufficiently indicated by the verbal terminations. Thus: *ho,* I have; *abbiamo,* we have; *siete?* are you? etc.

dov' è? (dovèh), where is?
dove sono? where are?
vi sono, there are.
risposta (fem.), answer.
scritto (skreètto), written.
sì, yes.
no (pronounce the *o* open, as in *not*), no.
ma, but.

CONVERSAZIONE.

Dov' è il signore? è in casa?

Dove sono i ragazzi?

Il signore non è in casa, ma i ragazzi sono in giardino.

Ha scritto la lèttera al mèdico?

Sì, ma non ho ricevuto risposta.

Egli non è a Londra, è a Parigi.

Vi sono delle pere nel giardino?

No, ma vi sono delle rose.

Lo scolaro ha libri, penne, buste?

Noi abbiamo temperini libri penne, ma non abbiamo buste.

Dove sono gli amici?

Il mèdico è in casa dello scultore, il signore e la signora sono in giardino coi ragazzi.

Continued

FRENCH

Continued from page 1878

By Louis A. Barbé, B.A.

PERSONAL PRONOUNS

1. There are two forms of personal pronouns (*pronoms personnels*): the conjunctive form and the disjunctive form.

Conjunctive Personal Pronouns. The conjunctive personal pronouns are always closely joined to a verb, and can be used only when the verb is actually expressed—not understood. Used as subjects they are:

1st person: *je,* I; *nous,* we.
2nd person: *tu,* thou; *vous,* you.
3rd person: *il,* he, it; *elle,* she, it,
ils, (m.), *elles* (f.), they.

The conjunctive personal pronouns as objects, both direct (accusative) and indirect (dative) are:

1st person: *me,* me, to me; *nous,* us, to us.
2nd person: *te,* thee, to thee; *vous,* you, to you.
3rd person (direct): *le,* him, it; *la,* her, it; *les,* them (mas. and fem.).
3rd person (indirect): *lui,* to him, to her, to it; *leur,* to them (mas. and fem.).

2. The conjunctive personal pronouns as subjects precede the verb: *je parle,* I speak; *il ne parle pas,* he does not speak.

Exceptions: (*a*) In interrogations and exclamations the pronoun comes after the verb: *avez-vous,* have you? *parlent-ils,* do they speak? When, in the third person singular, the verb ends with a vowel, a *-t-*, with a hyphen before and after it, is inserted between the verb and the subject: *parle-t-il,* does he speak; *a-t-elle,* has she?

(*b*) The subject follows the verb, when that verb refers to what has been expressed in direct speech: *Sortez, dit-il,* go out, said he. This inversion is optional in English, but obligatory in French, and also takes place when the subject is a noun: *viens ici, dit mon père,* come here, said my father.

(*c*) The subject follows the verb in sentences beginning with *aussi,* therefore, *peut-être,* perhaps; *encore,* even then, etc.: *Il secourut toujours l'infortune; aussi a-t-il à son tour trouvé*

des amis; He always relieved misfortune; therefore he, in his turn, has found friends.

3. The conjunctive personal pronouns as objects (accusative or dative) always precede the verb, except when the verb is in the imperative: *je les vois,* I see them; *il me l'a donné,* he has given it to me; but, *donnez-le-lui,* give it to him.

When the verb is in the imperative affirmative, the disjunctive forms *moi, toi* are used instead of *me, te; donnez-le-moi,* give it to me; *prêtez-lui votre canif,* lend him your penknife (see 7).

As a conjunctive pronoun, *lui* is both masculine and feminine; thus, *je lui parle* is both I speak to him, and I speak to her; *donnez-lui,* give him, and give her.

4. When a verb has the same person for both subject and object, it is said to be reflexive (*réfléchi*), and the personal pronouns used as objects become reflexive pronouns. There is then a special form, *se,* for the third person, singular and plural. These reflexive personal pronouns are:

me, myself, to myself; *nous,* ourselves, to ourselves.
te, thyself, to thyself; *vous,* yourselves, to yourselves.
se, himself, to himself; herself, to herself.
se, themselves, to themselves (mas. and fem.).

Examples: *Je me flatte,* I flatter myself; *tu te trompes,* thou art mistaken; *il se couche,* he goes to bed; *nous nous levons,* we get up; *vous vous habillez,* you dress; *ils* (*elles*) *s'amusent,* they enjoy themselves.

5. *En* and *y* are pronouns used more particularly, the latter almost exclusively, with reference to inanimate objects. They may be considered as equivalent to English neuter forms. *En* means "of it," "of them," "some." *Y* means "to it," "to them," and also "to that place," *i.e.* "there."

6. When a verb has several pronouns as objects, the order in which they are to be placed is as follows:

1st, *me, te, se, nous, vous;* 2nd, *le, la, les;* 3rd, *lui, leur;* 4th, *y;* 5th, *en.*

Examples: *Il me le donne,* he gives it to me; *nous les leur prêtons,* we lend them to them; *nous nous y sommes consacrés,* we have devoted ourselves to it; *vous m'en avez parlé,* you have spoken to me about (of) it; *ils lui en ont donné,* they have given him some.

7. If the verb be in the imperative and affirmative, the pronominal objects follow it, in the same order as in English. *Me* and *te* then become *moi* and *toi;* and *m', t',* before *en.*

Examples: *Donnez-le-moi,* give it to me; *prêtez-les-leur,* lend them to them; *donnez-m'en,* give me some; *pensez-y,* think of (to) it.

8. If the imperative is negative, this change does not take place, and the pronouns remain before the verb.

Examples: *Ne le leur donnez pas,* do not give it to them; *ne m'en parlez pas,* do not speak to me about (of) it; *ne vous y opposez pas,* do not oppose (yourself to) it.

9. The following table shows the relative position of all the conjunctive personal pronouns, and also of the negative *ne . . . pas* (*point, plus, jamais,* etc.), when used in connection with them:

1.	2.	3.	4.	5.	6.	7.	8.	9	10.	
je *tu* *il* *elle* *nous* *vous* *ils* *elles*	*ne*	*me* *te* *se* *nous* *vous* *se*	*le* *la* *les*	*lui* *leur*	*y*	*en*	*auxiliary verb, or simple tense.*	*pas,* *point,* *plus,* *&c.*	*past participle of compound tense*	*If the sentence is interrogative, the subjects in* 1 *come after* 8.

Voici and *voilà* are made up of the imperative *vois,* behold, with *ci* for *ici,* here, and *là,* there. Like verbs, they govern the pronoun in the objective case, and are preceded by it.

Examples: *Où est mon canif? Le voici,* where is my penknife? Here it is; *Où est ma poupée? La voilà,* where is my doll? There it is; *Où sont leurs joujoux? Les voilà,* where are their toys? There they are.

Exercise XV.

1. I am looking (for) (*cherche*) my book and my pens.
2. You have spoken to my brother and sister.
3. He has given a present (*cadeau*) to his friend.
4. He is looking (for) me.
5. She is speaking to you.
6. We have given him a watch (*montre,* f.).
7. He does not speak to them.
8. Has she given them a present?
9. Has he found his watch?
10. I give thee that, he said to me.
11. Give it (m.) to me, said my father to us.
12. Buy (*achète*) thyself an umbrella (*parapluie,* m.).
13. We get up every day at seven o'clock.
14. They never go to bed before eleven o'clock.
15. We give it (m.) to them.
16. She lends it (f.) to you.
17. He has given us some.
18. You have spoken to us about (of) it.
19. If you have any money, give him some.
20. Do not speak to him about it.
21. We do not oppose (*opposer*) it (oppose ourselves to it).
22. If you are looking for your gloves, here they are.
23. You are mistaken.
24. They flatter themselves.

Disjunctive Personal Pronouns. The disjunctive personal pronouns, whether used as subjects or as objects, have but one form. They are:

moi, I, me, to me — *nous,* we, us, to us
toi, thou, thee, to thee — *vous,* you, to you

lui, he, him, to him	*eux* (m.), they, them, to them.
elle, she, her, to her	*elles* (f.), they, them, to them.

The reflexive pronoun *se* also has a disjunctive form, *soi*. Example: *Chacun pour soi*, each one for himself.

2. The disjunctive form is used after prepositions: *nous sommes pour eux et contre lui*, we are for them and against him.

But when a single pronoun is the indirect object (dative), the proposition *à*, to, is not expressed. The pronoun is in the conjunctive form and precedes the verb. If the verb is reflexive, however, the preposition *à* is expressed: *nous nous fions à eux*, we trust to them.

3. When a personal pronoun is used alone, as either subject or object of a verb understood, the disjunctive form is required:

Qui lui a répondu? Moi, who answered him? I; *Qui a-t-il vu? Eux*, whom did he see? Them.

4. When a personal pronoun is the "logical subject" of the verb *être*, preceded by *ce*, the disjunctive form is required:

c'est moi, it is I	*c'est nous*, it is we
c'est toi, it is thou	*c'est vous*, it is you
c'est lui, it is he	*ce sont eux*, it is they (m.)
c'est elle, it is she	*ce sont elles*, it is they (f.)

In this construction the verb is plural when followed by a pronoun in the third person plural.

5. When a verb has several subjects, or several objects, those of them that are pronouns must be in the disjunctive form. In this construction it is usual to introduce an additional pronoun in the conjunctive form, including all the others:

Toi, lui et moi, nous serons ensemble, thou, he and I (we), shall be together.

Il nous verra, toi et moi, he will see (us), you and me.

6. The pronoun coming after *que*, than, as subject or object of a verb understood, must be used in the disjunctive form:

J'y ai été plus souvent que lui, I have been there oftener than he.

Il vous voit plus souvent que moi, he sees you oftener than me.

7. A personal pronoun immediately preceding a relative must be in the disjunctive form:

Moi qui vous parle, je l'ai vu de mes yeux, I who speak to you, I saw it with my own eyes.

8. A pronoun is emphasised by being used once in the disjunctive and again in the conjunctive form:

You work and *I* play, *toi, tu travailles et moi, je joue*.

In this construction the disjunctive pronoun may be placed either before the conjunctive or after the verb:

Tu travailles toi, you work.

9. If the emphasised pronoun is in the third person, and is the subject of a verb, the conjunctive form may be omitted:

Lui pense ainsi, mais eux pensent autrement, *he* thinks thus, *they* think otherwise.

But if the emphasised pronoun be objective, both forms are used:

Je le crois lui, eux je ne les crois pas, I believe *him, them* I do not believe.

10. In elliptical sentences, when the only verb expressed is in the infinitive, the pronoun is used in the disjunctive form:

Moi vous trahir, I betray you!

11. The disjunctive form is used with a participle to form an "absolute" construction:

Lui mort, nous n'aurons plus de chef, he being dead, we shall no longer have a leader.

12. The disjunctive pronouns form with the preposition *chez* expressions that mean "at my house" or "at home," etc.:

chez moi, at (to) my house
chez toi, at (to) thy house
chez lui, at (to) his house
chez elle, at (to) her house
chez nous, at (to) our house
chez vous, at (to) your house
chez eux, at (to) their (m.) house
chez elles, at (to) their (f.) house

Il n'est pas chez lui, he is not at home.

Nous sommes toujours chez nous le soir, we are always at home in the evening.

Est-il allé chez vous? Did he go to your house?

13. The disjunctive forms, with *même* joined to them by a hyphen, become emphatic personal pronouns:

moi-même, myself	*soi-même*, oneself
toi-même, thyself	*nous-mêmes*, ourselves
lui-même, himself	*vous-mêmes*, yourselves
elle-même, herself	*eux-mêmes* (m.), themselves
elles-mêmes (f.) themselves	

These forms are not reflexive, and may not come immediately after the conjunctive subjects *je*, *tu*, etc.:

Il me l'a dit lui-même, he himself told me.

They may be used in connection with reflexive verbs:

Il s'habille lui-même, he dresses by himself (*lit.*, he himself dresses himself).

14. In French the second person singular and the second person plural are used as forms of address. The singular implies very great familiarity. The use of this familiar form is called *tutoyer*, as:

Nous nous tutoyons, we "thou-thee" each other.

Exercise XVI.

1. They are against me and for them.
2. She does not trust him.
3. Whom have you seen? Him.
4. Who answered him? They (m.).
5. Who is there? It is I.
6. We shall go (*irons*) together, thou and I.
7. He has spoken to him and me.
8. We have been there oftener than they.
9. She is more intelligent than he.
10. They, whom we thought (*que nous croyions*) our friends, have betrayed (*trahis*) us.
11. *He* works, but *you* do nothing but (*ne fais que*) play.
12. He say (*dire*) such a thing!

13. They have supplied (*fourni*) the money; he has built (*bâti*) the house.
14. If you do not believe (*croyez*) *me*, will you believe (*croirez*) *him?*
15. That child has written the letter himself.
16. They (f.) have told (*dit*) me themselves that they would come (*viendraient*) this evening.
17. They (m.) are never at home in the evening.
18. Each one for himself and God for all.

Key to Exercise XIV. Page 1877

Le territoire de la République française est d'environ cinq cent trente-six mille cinq cents kilomètres carrés. Sa superficie est à peu près treize fois la superficie de la Suisse et plus de treize fois la superficie de la Belgique. Sa population est de trente-huit millions six cent mille habitants. Chaque kilomètre carré a environ soixante-douze habitants. Il y a en France soixante mille juifs et six cent cinquante mille protestants. Elle a quatre-vingt-six départements. Son climat est tempéré: sa température moyenne annuelle est de soixante degrés. Sa chute de pluies est de quatre-vingts centimètres. La France forme une république. À la tête du pouvoir exécutif est placé le président de la République. Il est élu pour une période de sept ans. Le service militaire est obligatoire en France dès l'âge de vingt ans. La durée du service est de vingt-cinq ans: trois ans dans l'armée active, dix ans dans la réserve de l'armée active, six ans dans l'armée territoriale et six ans dans la réserve de l'armée territoriale. En temps de paix l'effectif est de cinq cent soixante mille hommes environ. La marine française comprend quatre cent cinquante navires de guerre. Ils sont montés par environ cent mille matelots et soldats de marine. Il y a cinq grands ports militaires. Paris, la capitale de la France, a une population d'environ deux millions et demi. Lyon et Marseille sont aussi deux des plus grandes villes de la France. À Marseille il y a quatre cent quatre mille habitants; à Lyon il y en a quatre cent vingt mille. Paris a plus de neuf cent mille habitants de plus que ces deux villes ensemble. Par ses industries et son commerce Paris est une des premières villes du monde. Marseille est le premier port de toute la Méditerranée et une des dix ou douze places commerciales les plus importantes du globe. Le commerce de la France est très considérable. La valeur moyenne de son commerce extérieur est de sept mille cinq cents millions ou sept milliards et demi: quatre pour l'importation, et trois et demi pour l'exportation. La plus longue rivière de la France est la Loire. La longueur de la Loire est de mille vingt kilomètres. Les lignes des chemins de fer de la France ont une longueur totale de quarante mille kilomètres. Les Anglais mesurent les distances par milles, les Français par kilomètres. Le mille anglais est de mille six cent neuf mètres. Les Français indiquent la valeur par francs et centimes. Le franc vaut un peu moins de dix "pence" anglais. Le centime est la centième partie du franc. Il y a des pièces d'argent de cinquante centimes et des pièces d'or de dix francs. La plus grosse pièce d'argent est la pièce de cinq francs. En France les jours de fête sont le premier janvier ou jour de l'An, Pâques, l'Ascension, la Pentecôte, la Toussaint, et le jour de Noël. La Toussaint est toujours le premier novembre et Noël le vingt-cinq décembre. Pâques tombe entre le vingt et un mars et le vingt-six avril. L'Ascension est aussi une fête mobile. Elle tombe quarante jours après Pâques. La Pentecôte tombe dix jours plus tard, c'est-à-dire cinquante jours après Pâques. Les Français célèbrent leur fête nationale le quatorze juillet, en mémoire de la prise de la Bastille en mil sept cent quatre-vingt-neuf.

Continued

GERMAN

Continued from page 1880

By P. G. Konody and Dr. Osten

XXXI. The Reflective Pronouns are used in German to express the reflection of an action on the acting person:

Sing. 1. Ich waſche mir die Hände, I wash my hands [I wash to myself (*dat.*) the hands];
2. du wäſchſt dir die Hände, thou washest thy hands [thou washest to thyself the hands];
3. er, ſie, es wäſcht ſich die Hände, he, she, it washes his, her, its hands;
Plur. 1. wir waſchen uns die Hände, we wash our hands;
2. ihr waſcht euch die Hände, you wash your hands;
3. ſie waſchen ſich die Hände, they wash their hands.

Alike in the accusative:

Sing. 1. Ich waſche mich, I wash myself;
2. du wäſchſt dich, thou washest thyself;
Sing. 3. er, ſie, es wäſcht ſich, he washes himself, etc.;
Plur. 1. wir waſchen uns, we wash ourselves;
2. ihr waſcht euch, you wash yourselves;
3. ſie waſchen ſich, they wash themselves.

In the first and second person the personal pronoun [XI.] is used in the required case. Only the third person (*sing.:* er, ſie, es; *pl.:* ſie) has a separate reflective pronoun—ſich—for all genders and numbers, both in the dative and accusative.

The reflective pronouns are employed in all tenses with the verbs of which they reflect the action. The imperative is: *sing.* 2 waſche dir die Hände! (*dat.*); and waſche dich! (*acc.*). Civil address: waſchen Sie ſich die Hände! and waſchen Sie ſich!

1. The reflective pronoun immediately follows the finite verb in simple sentences. In the

compound tenses it therefore stands between the finite verb and the constant forms: ich unterhal'te mich, I enjoy myself; and ich habe mich unterhal'ten, I have enjoyed myself; ich werde mich unterhal'ten, I shall enjoy myself; etc.

2. The reciprocity of a reflected action is not expressed by sich, but by einander, each other, one another: sie liebten sich, they loved themselves; and: sie liebten einander, they loved each other.

XXXII. The Cardinal Numerals are:

eins	1	elf	11	dreißig	30
zwei	2	zwölf	12	vierzig	40
drei	3	dreizehn	13	fünfzig	50
vier	4	vierzehn	14	sechzig	60
fünf	5	fünfzehn	15	siebzig	70
sechs	6	sechzehn	16	achtzig	80
sieben	7	siebzehn	17	neunzig	90
acht	8	achtzehn	18	hundert	100
neun	9	neunzehn	19	hundert und eins	
zehn	10	zwanzig	20		101 etc.

tausend .. .. 1000 eine Million, a million.

After 20 the unit always precedes the multiple of ten, with which it is connected by the conjunction und: einundzwanzig, 21; zweiundzwanzig, 22; etc., corresponding to the English form one and twenty, etc. The numeral eins casts off the s at the beginning and in the middle of a compound numeral, but retains it at the end: einunddreißig, 31; hunderteinundsechzig, 161; but, hundertundeins, 101; etc. Also: es ist ein Uhr, it is one o'clock. But if Uhr (o'clock) is omitted: es ist Eins, it is one [o'clock]. The hundreds, thousands, etc., are formed as in English: zweihundert, 200; fünfhundert, 500; zehntausend, 10,000; hundert tausend, 100,000; fünf hundert tausend, 500,000; etc.

1. (*a*) The numeral ein (*m.*), eine (*f.*), ein (*n.*) takes the declensive inflections of the indefinite article [see V., 4] when preceding the substantive as attributive adjective. It is distinguished from the indefinite article only by the stress laid upon it: er aß nur einen Apfel, he ate only one apple; but, er aß einen Apfel, he ate an apple.

(*b*) If not directly connected with a substantive, it takes the *strong* declension of adjectives [see XXVI., 2] with the genitive -es: einer (*nom.*) von den drei Männern, one of the three men; ich sah einen (*acc.*), I saw one; etc. When used substantively it takes a capital letter: Einer sagte es mir, one [person] told it me.

(*c*) With the definite article it takes the inflections of the weak declension of adjectives [see XXVI., 1]: der eine von den drei Männern, [the] one of the three men. Der Torni'ster ein-es and des ein-en Soldaten, the knapsack of one soldier, and .... of [the] one of the soldiers. Einer unter euch, one among you; and der ein-e unter euch, etc.

2. The numerals zwei and drei form the genitive with the suffix -er, and the dative with -en, if the case is not easily recognisable by the inflection of some other noun adjunct (definite article, pronoun, adjective, etc.): Er war der Vater zwei-er [or drei-er] (*gen.*) Kinder; he was the father of two [three] children; and er war der Vater zwei [drei] schön-er (*gen.*) Kinder, he was the father of two [three] beautiful children; or, er war der Vater der (*gen.*) zwei Kinder, he was the father of the two children. Er war drei-en (*dat.*) Mädchen ein Vater, and er war den (*dat.*) drei Mädchen ein Vater, he was a father to the three girls. The higher numerals which do not admit these inflections are usually circumscribed with the preposition von, of: er war der Vater von sechs Kindern, etc.

3. The numerals 1—19, if not immediately followed by a substantive sometimes take an -e in the nominative and accusative (zwei-e, drei-e, fünf-e,*) neun-e, etc., and -en in the dative: mit (3) vier-en, sechs-en, etc. Both these forms are used in idiomatic expressions, when the number is understood to comprise the substantive: wir waren unser fünf-e, there were five of us [persons]; er fährt mit sechs-en, he drives with six [horses]; etc.

4. The numerals are also used as substantives, with a gender and written with capitals: die (eine) Eins (*f.*) 1; also der Einser (*m.*), the one; die Elf (*f.*) 11; das Hundert (*n.*) the hundred; das Tausend (*n.*); die (eine) Million (*f.*), Billion (*f.*); die (eine) Milliarde (*f.*), 1000 millions, etc; also in compounds: das Jahrhundert, the century, etc.; and they take the declension—masculines and neuters strong, genitive with -s, plural with suffix -e or unchanged: des Einser-s, des Hundert-s; *pl.* die Hundert-e, die Tausend-e, die Einser; but die Million-en, die Milliarde-n (weak).

XXXIII. The Strong Verbs with the Stem Vowel -i- change it in the imperfect into -a- and in the past participle into -u-, -o-, or -e-. The list of verbs, with their different tenses, given on the next page must be carefully committed to memory.

EXAMINATION PAPER.

1. In which person, and for which declensive cases, does the reflective pronoun take a distinct form?
2. Where is the reflective pronoun placed in the normal arrangement of simple sentences?
3. What alterations does the cardinal numeral 1 undergo in German when placed at the beginning, in the middle, and at the end of a compound numeral?
4. Which is the place of the unit in compound numerals above 20?
5. When does the numeral 1 take the inflections of the strong, and when those of the weak declension of adjectives?
6. What are the suffixes for the genitive and dative of the numerals 2 and 3; when are they employed, and in which numerals is the genitive circumscribed by a preposition?
7. Which vowels are taken in the imperfect, and which in the past participle, by the strong verbs with the stem-vowel -i-?
8. Why do some verbs take the prefix ge- in the past participle, whilst others remain without it?

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* Those ending in f (fünf, elf, zwölf) pronounced like w: fünfe (pronounced fünwe), etc.

Infinitive		Present Tense Indicative I., II., III., Sing.	Imperfect *Indicative*	Imperfect *Subjunctive*	Imperative Singular	Past Participle
bedingen *	to stipulate, contract	ich beding-e, -st, -t	ich bedang	ich bedänge	beding(e)	bedungen
binden	to bind	ich bind-e, -est, -et	ich band	ich bände	bind(e)	gebunden
dringen †	to press, penetrate, rush in	ich dring-e, -st, -t	ich drang	ich dränge	dring(e)	gedrungen
empfinden	to feel	ich empfind-e, -est, -et	ich empfand	ich empfände	empfind(e)	empfunden
finden	to find	ich find-e, est, -et	ich fand	ich fände	find(e)	gefunden
gelingen	to succeed	es geling-t (used only in the neuter)	es gelang	es gelänge	es geling(e)	gelungen
klingen	to sound	ich kling-e, -st, -t	ich klang	ich klänge	kling(e)	geklungen
ringen	to wrestle	ich ring-e, -st, -t	ich rang	ich ränge	ring(e)	gerungen
schlingen	to entwine, wind, swallow greedily	ich schling-e, -st, -t	ich schlang	ich schlänge	schling(e)	geschlungen
schwinden	to vanish, dwindle	ich schwind-e, -est, -et	ich schwand	ich schwände	schwind(e)	geschwunden
schwingen	to swing	ich schwing-e, -st, -t	ich schwang	ich schwänge	schwing(e)	geschwungen
singen	to sing	ich sing-e, -st, -t	ich sang	ich sänge	sing(e)	gesungen
sinken	to sink	ich sink-e, -st, -t	ich sank	ich sänke	sink(e)	gesunken
springen	to leap, jump	ich spring-e, -st, -t	ich sprang	ich spränge	spring(e)	gesprungen
stinken	to stink,	ich stink-e, -st, -t	ich stank	ich stänke	stink(e)	gestunken
trinken	to drink	ich trink-e, -st, -t	ich trank	ich tränke	trink(e)	getrunken
winden	to wind, twist	ich wind-e, -est, -et	ich wand	ich wände	wind(e)	gewunden
zwingen	to constrain, force	ich zwing-e, -st, -t	ich zwang	ich zwänge	zwing(e)	gezwungen
beginnen ‡	to begin	ich beginn-e, -st, -t	ich begann	ich begänne also (begönne)	beginn(e)	begonnen
besinnen	to consider, deliberate	ich besinn-e, -st, -t	ich besann	ich besänne (besönne)	besinn(e)	besonnen
gewinnen	to win	ich gewinn-e, -st, -t	ich gewann	ich gewänne (gewönne)	gewinn(e)	gewonnen
rinnen	to flow, run	ich rinn-e, -st, -t	ich rann	ich ränne (rönne)	rinn(e)	geronnen
schwimmen	to swim	ich schwimm-e, -st, -t	ich schwamm	ich schwämme (schwömme)	schwimm(e)	geschwommen
sinnen	to meditate	ich sinn-e, -st, -t	ich sann	ich sänne (sönne)	sinn(e)	gesonnen
spinnen	to spin	ich spinn-e, -st, -t	ich spann	ich spänne (spönne)	spinn(e)	gesponnen
bitten	to ask, beg	ich bitt-e, -est, -et	ich bat	ich bäte	bitt(e)	gebeten
besi'tzen	to possess	ich besitz-e, -est, -t	ich besaß	ich besäße	besitz(e)	besessen
liegen	to lie, to be located	ich lieg-e, -st, -t	ich lag	ich läge	lieg(e)	gelegen
si'tzen	to sit	ich sitz-e, -est, -t	ich saß	ich säße	sitz(e)	gesessen

* Dingen, to hire [ich ding-e, -st, -t]; imperfect indicative: ich dang, but *better:* dingte; subjunctive like imperative: ding(e); past participle: gedungen.

† The verbs with infinitives printed in italics are conjugated with sein (to be), all the others with haben (to have).

‡ Note the subjunctive alternative form with ö.

Note in the above verbs the formation of the past participle with and without the prefix ge-, and consider the reasons for its omission in several cases.

Exercise 1. Insert the missing reflective pronouns:

Ich beei'le . . . . .; er beeilt' . . . .; du
I hasten [myself]; he hastens [himself]; thou
liebst . . . . . .; wir retten . . . . . .; ich sagte
lovest thyself; we save ourselves; I said
. . . .; Sie sagten . . . .: ihr sagtet
to myself; you said to yourself; you said
. . . .; sie fürchteten . . . .;
to yourselves; they feared [themselves];
ich hatte . . . . gesagt; wir hatten . . . . . ruinirt;
I had said to myself; we had ruined ourselves;
er würde . . . getötet haben; sie unterhält' . . . . .;
he would have killed himself; she enjoys herself;
wir unterhiel'ten . . . . .; schämen Sie . . . . .!
we enjoyed ourselves; be ashamed of yourself!
rasiere . . . .!
shave thyself!

Exercise 2. Insert the missing numerals (fully written) and the declensive inflections.

Ich habe . . . . . Karten ; er gab mir . . . . Pfund
I have 21 cards ; he gave me £261
für das Jahr . . . . ; der Lehrer unterrich'tet
for the year 1901 ; the teacher instructs
. . . . Knaben und . . . . . . Mädchen, zusammen
42 boys and 57 girls, together
. . . . . . Kinder. Im russisch-japa'nischen Kriege
99 children. In the Russo-Japanese war
wurden . . . . Soldaten verwun'det — . . . .
247.589 soldiers were wounded — 145,437
Russen und . . . . . . Japaner. Wie viel ist . . . .
Russians and 102,152 Japanese. How much is 19
und . . . . . ? . . . . . ; . . . . . und . . . . ? . . . .
and 13 ? 32 ; 14 and 9 ? 23.
Ein . . von euch hat es genommen.
One of you has taken it. —
Ich glaube es war der ein . . von den . . . . Soldaten ;
I believe it was [the] one of the five soldiers ;
er war der Vater zwei . . . Söhne,
he was the father of two sons, (or
with preposition): er war der Vater von . . . . Söhnen

Keys to Exercises in Examination Paper VIII. (Pages 1879–80).

[The exercises being now more advanced, Keys are given in each lesson to the exercises set in the previous Examination Paper.]

Exercise 1 (*a*). Der Griff mein e s Stockes ist schön; ich gab mein e m Freunde dein e n Stock; sie brach ihre Uhr; der Deckel ihr e r Uhr ist zerbrochen; er fuhr mit sein e n und mit ihr e n Pferden; ich ging zu ihr e m Arzte; sie gingen mit ihr e n Eltern in unser e n Garten und bewunderten die Schönheit unser e r Blumen. Eu(e)r e Freunde und die Brüder eu(e)r e r Freunde waren in eu(e)r e m Garten und pflückten eu(e)r e Blumen.

(*b*). Ihr Freund ist auch der mein e (or unser e); er brach nicht blos sein e Uhr, sondern auch die dein e, die ihr e, die uns(e)r e, die eu(e)r e, die ihr e und die Ihr e; die Schnelligkeit dein e s Hengstes ist größer als die des mein e n, des sein e n, des ihr e n, des uns(e)r e n, des eu(e)r e n, des ihr e n, des Ihr e n; seine Dogge lief hinter der mein e n, der dein e n, der ihr e n, der uns(e)r e n, der eu(e)r e n, der ihr e n, der Ihr e n; mein Pferd schlägt das dein e, das sein e, das ihr e, das eu(e)r e, das ihr e, das Ihr e; deine Freundinnen sind auch die uns(e)r e n, die ihr e n. Die Wolle mein e s Schirmes ist besser als die Seide des dein e n, des sein e n, des ihr e n, des uns(e)r e n, des eu(e)r e n, des ihr e n, des Ihr e n; ich glaube deinem Freunde mehr als dem mein e n, dem sein e n, dem ihr e n, dem uns(e)r e n, dem eu(e)r e n, dem ihr e n, dem Ihr e n; er liebt sein e n Freund mehr als den mein e n, den dein e n, den ihr e n, den uns(e)r e n, den eu(e)r e n, den ihr e n, den Ihren, etc.

(*c*). Der Stock ist mein e r, dein e r, sein e r, ihr e r, uns(e)r e r, eu(e)r e r, ihr e r, Ihr e r; die Dogge ist mein e, dein e, etc.; das Pferd ist mein e s, dein e s, etc.

(*d*). Insert the suffix -ig- between the possessive pronoun and its declensive termination, wherever the pronoun does not precede the substantive.

Exercise 2 (*a*) :

ich stehe auf	ich biete an	ich gebe aus
du stehst auf	du bietest an	du gibst aus
er steht auf	er bietet an	er gibt aus
wir stehen auf	wir bieten an	wir geben aus
ihr steht auf	ihr bietet an	ihr gebt aus
sie stehen auf	sie bieten an	sie geben aus
ich schließe bei	ich schlafe ein	ich komme hin
du schließt bei	du schläfst ein	du kommst hin
er schließt bei	er schläft ein	er kommt hin
wir schließen bei	wir schlafen ein	wir kommen hin
ihr schließet bei	ihr schlaft ein	ihr kommt hin
sie schließen bei	sie schlafen ein	sie kommen hin

ich nehme mit	ich falle um
du nimmst mit	du fällst um
er nimmt mit	er fällt um
wir nehmen mit	wir fallen um
ihr nehmt mit	ihr fallt um
sie nehmen mit	sie fallen um

(*b*). Ich verstehe, du verstehst, etc. ; ich stehe bei, du stehst bei, etc. ; ich verbiete, du verbietest, etc. ; ich biete auf, du bietest auf, etc. ; ich schließe aus, du schließt aus, etc. ; ich beschließe, du beschließt, etc. ; ich gefalle, du gefällst, etc. ; ich falle auf, du fällst auf, etc.

(*c*). Steh' auf ! Stehet auf ! Stehen Sie auf ! Biete an ! Bietet an ! Bieten Sie an ! Gib aus ! Gebet aus ! Geben Sie aus ! Schließ' bei ! Schließet bei ! Schließen Sie bei ! Schlaf' ein ! Schlafet ein ! Schlafen Sie ein ! Komm' hin ! Kommt hin ! Kommen Sie hin ! Nimm' mit ! Nehmet mit ! Nehmen Sie mit ! Fall um ! Fallet um ! Fallen Sie um ! Versteh ! Versteht ! Verstehen Sie ! Steh' bei ! Steht bei ! Stehen Sie bei ! Verbiet ! Verbietet ! Verbieten Sie ! Biete auf ! Bietet auf ! Bieten Sie auf ! Schließ aus ! Schließet aus ! Schließen Sie aus ! 'Beschließ ! Beschließet ! Beschließen Sie ! Gefalle ! Gefallet ! Gefallen Sie ! Fall' auf ! Fallet auf ! Fallen Sie auf !

Exercise 3. Der Schüler hat (hatte) gelernt ; der Lehrer hat (hatte) das Fenster geöffnet ; der Künstler hat (hatte) ein Bild gezeichnet ; das Mädchen hat (hatte) gelächelt ; der Gärtner hat (hatte) im Garten gearbeitet ; das Schiff ist (war) gesegelt ; die Kinder haben (hatten) gespielt ; die Mädchen sind (waren) errötet ; ich habe (hatte) meine Eltern geliebt ; er hat (hatte) Unsinn geredet ; du hast (hattest) eine Cigarre geraucht ; ihr habt (hattet) im Flusse gebadet ; sie haben (hatten) die Glocke geläutet ; die Kinder haben (hatten) ihr Spielzeug zerstört ; er hat (hatte) an der Türe gelauscht ; du hast (hattest) den Vater begrüßt.

Exercise 4 (*a*). Die Väter, die Löffel, die Äpfel, die Fenster, die Esel, die Brüder, die Onkel, die Vögel, die Reiter, die Fäden, die Veilchen, die Käse, die Sättel.

(*b*). die Berge, die Hunde, die Jahre, die Kenntnisse, die Hirsche, die Bewandtnisse, die Pferde, die Haare, die Kürbisse, die Labsale, die Abende, die Preise, die Moose, die Fließe, die Schuhe, die Sprosse (also Sprossen) die Geheimnisse.

(*c*). Die Ärzte, die Gänse, die Köpfe, die Bräute, die Hände, die Zähne, die Töpfe, die Fäuste, die Füchse, die Brüste, die Ströme, die Würste, die Krüge.

(*d*). Die Tücher, die Länder, die Kinder, die Gewänder, die Weiber, die Kräuter, die Lieder, die Fässer, die Dörfer, die Glieder, die Würmer, die Gespenster, die Völker.

(*e*). Das Roß, des Rosses, dem Rosse, das Roß, die Rosse, der Rosse, den Rossen, die Rosse ; das Los, des Loses, dem Lose, das Los, die Lose, der Lose, den Losen, die Lose ; das Hindernis, des Hindernisses, dem Hindernisse, das Hindernis, die Hindernisse, der Hindernisse, den Hindernissen, die Hindernisse.

Continued

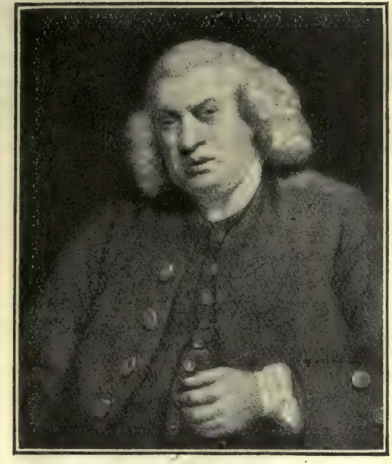
EIGHTEENTH CENTURY PROSE

2. In which the Study of this Period is continued from Dr. Johnson to Adam Smith. Specimens of the Writings of Burke and Gibbon

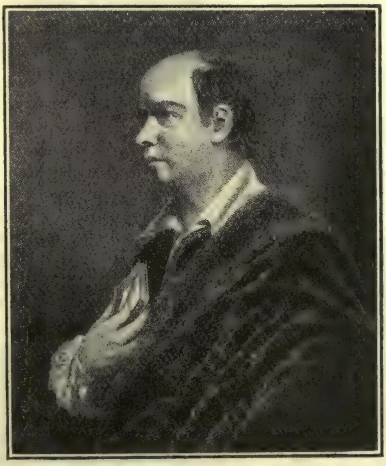
Continued from page 1904

By J. A. HAMMERTON

Dr. Johnson. SAMUEL JOHNSON (b. 1709; d. 1784), poet, essayist, dramatist, biographer, critic, novelist, lexicographer, and the "great Cham" of English literature, cannot be considered here in relation to his unrivalled position as a great and wise talker. There is only one way of realising Johnson's greatness: by mastering Boswell's biography. As to his influence on prose literature, Macaulay says: "His constant practice of padding out a sentence with useless epithets till it became as stiff as the bust of an exquisite; his antithetical forms of expression, constantly employed even where there is no opposition in the ideas expressed; his big words wasted on little things; his harsh inversions, so widely different from those graceful and easy inversions which give variety, spirit, and sweetness to the expression of our great old writers—all these peculiarities have been imitated by his admirers, and parodied by his assailants, till the public has become sick of the subject." Gibbon, the historian of Roman decadence, lived to write; Johnson, an infinitely greater man, wrote to live. To-day, Johnson's "Lives of the Poets" are read more, perhaps, than anything he wrote, but not for the accuracy of their data or their infallibility of judgment. They disclose to us not fine literary instinct so much as fine human sympathy. His prose tale of "Rasselas, Prince of Abyssinia," written to defray the cost of his mother's funeral, has been aptly described as a prose version of his poem on "The Vanity of Human Wishes." His great "Dictionary" was the first of its kind. It stands almost alone as the work of one man. Its value and influence have been great, and even to-day, except for its weakness on the side of etymology, a weakness due to the fact that Johnson's Latin learning was not approached by his knowledge of Anglo-Saxon, it is a standard book of reference. The ordinary reader should have some acquaintance with the "Lives of the Poets," and "Rasselas" he is not likely to miss. For the rest, to know this grand old character in Boswell's biography is, as it was to love "Aspasia," "a liberal education."



DR. SAMUEL JOHNSON



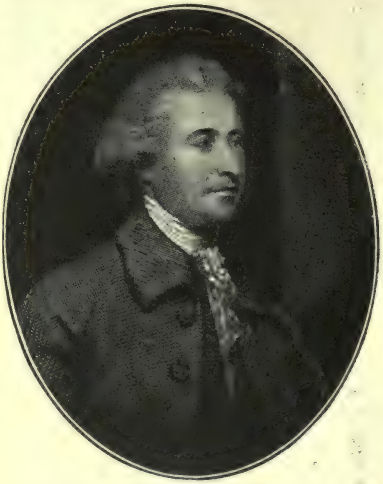
OLIVER GOLDSMITH

Oliver Goldsmith. The friendship between Steele and Addison was not greater than that between Johnson and OLIVER GOLDSMITH (b. 1728; d. 1774). But no greater contrast could be imagined than that afforded by the writings of the two men. "In prose style, as in poetic," says Mr. Gosse, "it is noticeable that Goldsmith has little in common with his great contemporaries, with their splendid burst of rhetoric and Latin pomp of speech, but that he goes back to the perfect plainness and simple grace of the Queen Anne men. He aims at a straightforward effect of pathos or of humour, accompanied, as a rule, with a colloquial ease of expression, an apparent absence of all effect or calculation." Goldsmith's prose approximates to that of Addison. The best examples of it are to be found in his "Citizen of the World" and the "Vicar of Wakefield." The first-named work consists of a series of letters supposed to have been written by a Chinaman resident in London, who was jotting down his experiences for the benefit of his friends in the Far East. The idea was not original, and it has since been imitated by innumerable writers, but the delightful wit and humour of Goldsmith's work have never been excelled. Ninety-eight of the letters appeared in the periodical called the "Public Ledger" in 1760. Twenty-five more were added when the letters were printed in volume form in 1762.

The "Vicar of Wakefield," Goldsmith's chief prose work, must be considered in its relation to the history of the English novel, which will form the most important part of our future study.

Historians and Philosophers. A number of historians, philosophers, theologians, and essayists must now be dismissed with the briefest possible mention :

ANTHONY ASHLEY COOPER, third Earl of Shaftesbury (b. 1671 ; d. 1713), wrote a volume entitled, "Characteristicks of Men, Manners, Opinions, Times," the views expounded in which influenced the Scottish philosopher Hutcheson, attracted attention on the Continent, and found reflection in Pope's "Essay on Man." HENRY ST. JOHN, first Viscount Bolingbroke (b. 1678 ; d. 1751), occupied himself with that side of philosophy affected by Shaftesbury, but is better known as a statesman. GEORGE BERKELEY, Bishop of Cloyne (b. 1685 ; d. 1753), was a man whose life apart from his writings is full of interest. As a philosopher he aimed at the overthrow of materialism. He was an acute and original thinker, he possessed a style of great force and elegance, and he is one of our most accomplished writers of dialogue. JOSEPH BUTLER, Bishop of Durham (b. 1692 ; d. 1752), was the author of a work on the "Analogy of Religion, Natural and Revealed, to the Constitution and Course of Nature," which won for him the name of "The Bacon of Theology," and remains a standard work in its own department of inquiry. DAVID HUME (b. 1711 ; d. 1776) was distinguished as an essayist, a philosopher, and a historian. Possessing wonderful clearness of mental vision, his style is marked by exceptional lucidity. An opponent of popular government, he was yet the first of our writers to recognise the importance of the social and scientific as well as the constitutional and political factors in the making of history. His influence as a philosopher was not inconsiderable in Scotland and Germany. The REV. WILLIAM ROBERTSON (b. 1721 ; d. 1793) was a painstaking historian of "Scotland," "Charles V.," and "America."



EDMUND BURKE

Gibbon's Great Work. EDWARD GIBBON (b. 1737 ; d. 1794) dedicated the best part of his life to the writing of his monumental history of "The Decline and Fall of the Roman Empire," and has been described as the one historian of his time "whom modern research has neither set aside nor threatened to set aside." The magnitude of his subject "is nobly sustained by the dignity of the treatment. The glowing imagination of the writer gives life and vigour to his rounded periods and to the stately and pompous march of his narrative. Perhaps his most unique merit is his supreme and almost epic power of moulding into a lucid unity a bewildering multitude of details, and giving life and sequence to the whole." (We retain in this quotation from a competent critic his error in "most unique." Since unique means "without like," it is incapable of degree. Anything that is "unique" cannot be so more or less.) Gibbon's great work, begun in 1768, was completed in 1788. The following brief passage, referring to the foundation of Constantinople, illustrates some of the chief features of the historian's style :

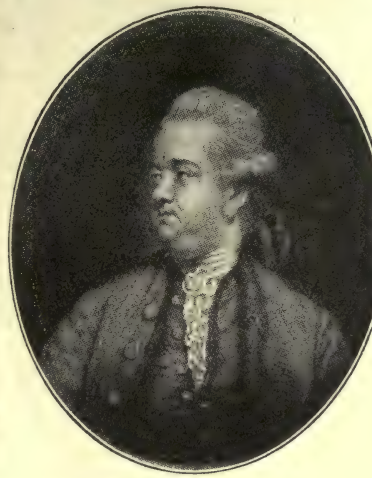
"The prospect of beauty, of safety, and of wealth united in a single spot was sufficient to justify the choice of Constantine. But as some mixture of prodigy and fable has in every age been supposed to reflect a becoming majesty on the origin of great cities, the Emperor was desirous of ascribing his resolution not so much to the uncertain counsels of human policy as to the eternal and infallible decrees of Divine wisdom. In one of his laws he had been careful to instruct posterity that in obedience to the commands of God he laid the everlasting foundations of Constantinople ; and though he has not condescended to relate in what manner the celestial inspiration was communicated to his mind, the defect of his modest silence has been liberally supplied by the ingenuity of succeeding writers, who describe the co-eternal vision which appeared to the fancy of Constantine as he slept within the walls of Byzantium."

"The Decline and Fall" is one of the inevitable items in any list of "books to read" and while there may be many who will find its stately poise of phrase and processional style of narrative monotonous, it is difficult to understand how any reader with a moderate endowment of imagination can fail to obtain from its study a continuous delight. No man is well read, or thoroughly furnished in his knowledge of one of the most momentous periods in the world's history, who has not gone through Gibbon's great masterpiece at least once.

Burke's Command of Prose. EDMUND BURKE (b. 1729 ; d. 1797) was, like Bolingbroke, a statesman and orator as well as an author. Matthew Arnold has described Burke as the greatest master of English prose style that ever lived. Mr. Gosse says : "Notwithstanding all its magnificence, it appears to me that the prose of Burke lacks the variety, the delicacy, the modulated music of the very finest writers. . . The greatest of English prose writers, we may be sure, would be found to have some command over laughter and tears, but Burke has none. . . . In short, the prose of

Burke may be felt to be the finest expression of a particular phase of the eighteenth century mind—a phase from which all the coarse fibre of the Renaissance, to its very last filament, had been extracted, where all is civilised, earnest, competent, and refined, but where the imagination is almost too completely under control." Apart from his speeches, Burke's principal prose works are: "A Vindication of Natural Society," written to ridicule Bolingbroke's views on religion; an "Inquiry into the Sublime and the Beautiful," and "Reflections on the Revolution in France" (1788). In the last-named work Burke set forth with much impressiveness his view that constitutional government, not revolution, was the true remedy for the troubles of the French nation. Here is a striking extract:

Specimen of Burke's Writing. "It it now sixteen or seventeen years since I saw the Queen of France, then the Dauphiness, at Versailles; and surely never lighted on this orb, which she hardly seemed to touch, a more delightful vision. I saw her just above the horizon, decorating and cheering the elevated sphere she had just begun to move in—glittering like the morning star, full of life and splendour and joy. Oh! what a revolution! And what a heart must I have to contemplate without emotion that elevation and that fall! Little did I dream, when she added titles of veneration to those of enthusiastic, distant, respectful love, that she should ever be obliged to carry the sharp antidote against disgrace concealed in that bosom. Little did I dream that I should have lived to see such disasters fallen upon her in a nation of gallant men, in a nation of men of honour and of cavaliers. I thought ten thousand swords must have leaped from their scabbards to avenge even a look that threatened her with insult. But the age of chivalry is gone. That of sophisters, economists, and calculators has succeeded, and the glory of Europe is extinguished for ever. Never, never more shall we behold that generous loyalty to rank and sex, that proud submission, that dignified obedience, that subordination of the heart which kept alive, even in servitude itself, the spirit of an exalted freedom. The unbought grace of life, the chief defence of nations, the nurse of manly sentiment and heroic enterprise, is gone! It is gone, that sensibility of principle, that chastity of honour, which felt a stain like a wound, which inspired courage whilst it mitigated ferocity, which ennobled whatever it touched, and under which vice itself lost half its evil by losing all its grossness."



EDWARD GIBBON

Importance of Studying Burke. Of all the eighteenth century writers, perhaps Burke is the one whom the student can least afford to palter with. De Quincey, who was no hasty eulogist, considered him the supreme writer of his time. Whether that judgment can be entirely justified, it is not easy to show, unless we could enter at much greater detail into comparisons between Burke and his contemporaries; but the fact remains that for much that makes for true citizenship as well as for the literary graces the student must have recourse to the works of Edmund Burke—his speeches not less than his writings. He helps us marvellously to a clear understanding of the public life of our country, though he may not always convince us. Indeed, his purpose was not to persuade and convince so much as to expound, in the most logical and reasonable manner of which he was capable, his own conclusions; and by our observing the process of his mind, we also acquire, in our own varying capacities, something of the orderly command of ideas and facts of which he was so able an exponent. We must not be content with knowing Burke in "The Sublime and the Beautiful"; his "Reflections on the Revolution in France," though far less known to the ordinary reader, is even more worthy of study, and his speeches present a rich field whence we may glean knowledge of life and wisdom.

Horace Walpole and Adam Smith. HORACE WALPOLE, fourth Earl of Orford (b. 1717; d. 1797), set up a private press, whence he issued "A Catalogue of Royal and Noble Authors." He also wrote "Anecdotes of Painting in England," a tragedy, "The Mysterious Mother," and a romance entitled, "The Castle of Otranto." He left nearly 3,000 letters and a "History of the Last Ten Years of the Reign of George II." Byron described Walpole as the "father of the first romance and the last tragedy in our language," an absurd piece of hyperbole. Walpole, however, possessed a brilliant style, which will long serve to keep his works alive and render his letters readable independently of their historical value.

ADAM SMITH (b. 1723; d. 1790) wrote a work entitled "The Wealth of Nations," which originated the study of "political economy" as a distinct branch of science, inspired a world-wide interest in the sources of wealth, and was responsible for the rise of the theory of Free Trade. "The Wealth of Nations" is a book that may still be studied with pleasure and profit. It affords an example of the way in which a "dry" subject may be treated so as to appeal to the popular mind.

Continued

THE PRINCESS GOWN

Double-breasted Coat—continued. Making and Putting on the Collar. Sleeves. Drafting a Princess Gown. Materials Required

By Mrs. W. H. SMITH and AZÉLINE LEWIS

The Outside Collar. This must be cut ½ in. longer and 1 in. wider than the pattern, so as to get the same well under, and also give sufficient scope for the curl given to the inside collar by the padding stitches. It is generally cut without a seam, and the pattern must be placed across the material—*i.e.*, with the weft of the cloth (not on the bias, as the inside collar), otherwise, should there be any pattern on the material, the effect would be far from satisfactory.

Before putting on the outside collar fold the cloth, place the pattern on, chalk-mark the centre-back, the crease-row, and round the collar. Having done this, remove the pattern, open the collar on the table, wrong side uppermost, with the stand towards the worker, slightly damp the crease-row, and press the stand back until it lies flat on the fall; shrink the crease-edge and well stretch the stand. The fall also must be stretched, so as to give plenty of leaf edge—*i.e.*, length from centre-back to end of collar; if this is not attended to the shrinking and stretching will have failed in their object. On no account must the crease-row be stretched.

Now place the cloth on the table right side uppermost; place the collar on the cloth, canvas uppermost, centre seam to the fold of cloth, and the crease-rows together; run a thread through the latter to hold the collar and cloth together, turn the collar over and pare the cloth away to within ⅜ in. of edge of fall and ends (*not* the stand).

Place the edge of cloth to edge of collar and baste thickly from end to end, well fulling the cloth on at both ends 1½ in. each side of corner, and easing it along the edge of fall. Now stitch the edge from end to end close to edge, with the fulness underneath just escaping the canvas when stitching. Remove all the basting stitches from the seam and crease-row, turn the cloth over, work the corners out evenly; baste round the edge, working the seam back under so that it will not show on the right side, put a few basting stitches across the corners, with the point of corner rolled over the finger while so doing, and pressing the cloth towards the point; baste through the centre, still pressing a little cloth towards the edge of fall.

Now run another thread through the crease-row of cloth and collar together, beginning and terminating ½ in. from each end. If the cloth is of a ravelly nature, it must be turned up and felled to the canvas, but if a good firm make, such as Melton, the edge can be left raw.

Sewing on the Collar. Place the coat on the knee right side uppermost; secure the centre of collar to the centre of back, and crease-row of collar to crease-row of lapel; baste the collar to the coat, beginning at the right hand, keeping it rather tight till the crease-row is reached, and long—*i.e.*, eased well, in the hollow of neck or gorge, and slightly easy from thence to the centre.

The other side of collar must be basted in the same way. Fell to the coat, holding this well over the hand; and having done so turn the coat over.

Before felling the collar-facing to coat, serge the canvas and lining to the seam. This acts as a stay to the collar and keeps it firm and in its proper position; if this is not done the collar will not be a success.

Basting the Edges together. Now turn in the edge of collar from the end to a little beyond the break, or crease, and baste; then treat the facing the same. Now baste the edges close together. Take a No. 7 or 8 needle and fine silk and draw the edges together with what is called the drawing-stitch, as described in BOY'S TAILORING. This must be done with great care, the object being to hide the stitches. Turn in the remainder of collar to the shoulder seam, which should be notched and cut away to within ¼ in.; fell till the shoulder is reached; tack the edge of collar at the back across the seam.

Work the left side of collar the same as the right. Now turn in the lining and fell to the collar, then take a needle and silk and stitch finely ½ in. below the crease right through the collar, starting 1 in. beyond the break, and terminating 1 in. from the break at the other side.

Having sewn the collar on satisfactorily, machine the edge to match the front of coat; remove the basting, and press.

A duplex board is almost a necessity; however, if this is not obtainable the next best thing is the pressing pad already described. Well press the inside of collar and lapels over a damp, clean cloth, which must be wrung practically dry; the edges of fronts should be pressed on the wrong side on a bare board.

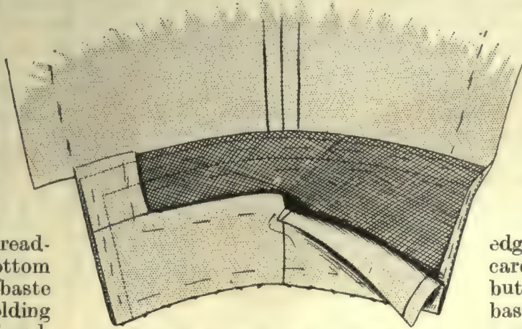
There are two ways of putting on a collar—the one is to seam it on, the other to fell; the latter, which we have given, is preferable, as it gives the thinnest and neatest finish.

The Sleeve. Baste and stitch the forearm seam, remove the basting, notch the seams three or four times in the hollow of the arm, open and press.

For the cuff, cut a piece of very fine canvas 4½ in. deep and wide enough to go right across the bottom of sleeve; this is to give firmness to the cuff and act as a stay for the buttons and buttonholes. Place the canvas on the sleeve

½ in. below the thread-marks of sleeve-hand, baste in position, run a thread along the depth of cuff, *i.e.*, 4 in. from the turn-up. If the inlay has not been left on the under part, a piece of cloth 1 in. wide must be seamed on to take its place. If it is a thick material it should be stoated [see BOYS' TAILORING]. But if inclined to ravel it must be notched ½ in. above the thread-marks of cuff, and the edges of both canvas and material turned in together. If of a firm, close make, the edges need not be turned in.

Now join a piece of cloth, 2 in. wide and 2½ in. long, on the buttonhole side and press the seam; this must be done on the buttonholes side whether the material is ravelly or not. Turn the facing in ⅛ in. inside the thread-marks, turn up the bottom to thread-marks, and baste two or three times, holding the cuff over the hand. Be very careful over the corner on the buttonholes side, as the sharp angle at that point should be worked in with the needle to give a rounded appearance. Baste the edge, then turn in the facings on button stand ⅛ in. from the edge; make the point neat, and baste. Secure firmly the edge of turn-up to canvas, and fell both edges neatly; remove the basting, but not the serging, and give a good press to make the edges as thin as possible.

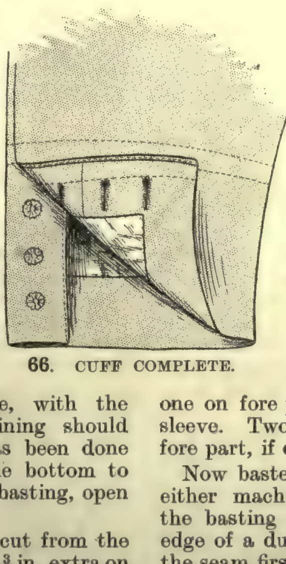


65. CUFF READY FOR MACHINING.

Machine the cuff, starting at the bottom on button side; stitch close to the edge, then along the thread-mark of cuff, down the buttonhole side, close to the edge, and back again ⅜ in. from the first row, keeping the corners quite square, and terminating at the top of cuff at the back seam [**65**].

Space the buttonholes and work them (three will be sufficient); they should be 1 in. apart, the first one being 1 in. from the bottom; work them according to directions given in the BOYS' TAILORING section.

Now place the edge of buttonholes side close to the thread-marks on under part; mark through the eyes with chalk for the position of buttons, and put a thread-mark in each. Place the edge of buttonholes side on the thread-marks of button side, with the buttons quite even; the machining should meet at the top of cuff if it has been done evenly. Baste the seam, from the bottom to the top, and stitch; remove the basting, open and press [**66**].



66. CUFF COMPLETE.

Linings. The lining must be cut from the same pattern as the cloth, allowing ¾ in. extra on the top of both parts; be sure and leave the same amount of inlays on hind part of top sleeve, and cut the bottom 1 in. shorter; baste the seams and stitch them, leaving the back seam open for the cuffs.

Now insert the lining. Both sleeve and lining must be inside out. Place the sleeve on the table, under-arm uppermost; place the lining on, under-arm to under-arm, leaving the lining ¾ in. above the top of sleeve; baste to the seams on both sides, beginning 3½ in. from the top, and keeping the lining very easy; place the hand through the top of lining, take hold of the bottom of sleeve, and draw through. Smooth the lining, notch it at the top of cuff, 1½ in.; turn in the edges all round, taking care that it escapes the buttonholes by ½ in.; baste the sleeve, and fell neatly to cuff.

Pressing. Place the narrow end of sleeve-board in the sleeve and well press the cuff; now turn the sleeve, and it is ready to insert in the coat. Turn the lining back from the top, to keep it out of the way while basting in the sleeve. Take the coat and cut away any superfluous canvas there may be from the armhole, secure a narrow linen stay to the back of armhole, as from J^a to 1 in. beyond I, holding the stay rather tight at that part. Secure the lining to the armhole, and thread-mark the turning—*i.e.*, ⅜ in. from the edge of cloth.

Inserting the Sleeve. Secure the back seam to the back pitch (J^a), and the front seam to the front pitch, which is generally ¾ in. up from bust-line on armhole curve; baste the sleeve from the back pitch to the forearm pitch, easing it under the arm, and slightly easing it 2 in. above the front pitch.

We must now arrange the pleats. There should be a box-pleat in the centre of top, *i.e.*, the centre of pleat should be on a line with shoulder seam. Two pleats are arranged at the back of box-pleat, and three in the front, all in a downward direction. The fold of the last pleat should be on J^a, and the bottom one on fore part 2 in. above the front pitch of sleeve. Two pleats only can be put in the fore part, if desired, instead of three.

Now baste the top of sleeve to armhole, and either machine or stitch by hand; remove the basting and press the seam open on the edge of a duplex board, very slightly damping the seam first, and pressing with a very narrow

iron. If a narrow one is not available, use the point only of a flat iron. Serge the turned-back seam to the lining; cut a piece of canvas (the shape of a dress-preserver) the length from first to last pleat, 2 in. to 3 in. deep in the centre—this is to make the head of the sleeve stand out nicely—serge the canvas to the seam, leaving the rounded part free. Now pleat the top of lining to match the top of sleeve, and fell to the lining of coat.

On no account must the sleeve lining be a tight one.

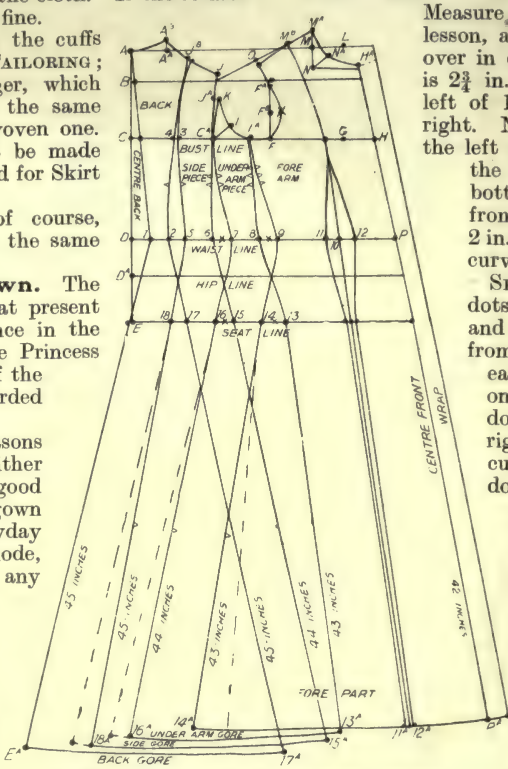
If the material is thin the canvas or muslin can be pleated in with the cloth. If the former is used it must be very fine.

Sew the buttons on the cuffs as described in BOYS' TAILORING; and, finally, the hanger, which last can be either of the same lining as coat or a woven one. If the former, it must be made and sewn on as directed for Skirt in DRESSMAKING.

Both sleeves are, of course, made and inserted in the same way.

The Princess Gown. The two styles which are at present striving for pre-eminence in the world of dress are the Princess and the Empire, and of the two the former is accorded the greater favour.

There are various reasons for this, as, though neither is suited to any but good figures, the Princess gown is more adapted to everyday use than the Empire mode, and does not mean any alteration of waist-line. We have therefore selected this for instruction in our next lesson.



67. DRAFTING FOR PRINCESS GOWN

Measurements. Neck, 14 in.; top of collar, 13 in.; back, 16 in.; chest, 34 in.; waist, 24 in.; nape to waist, 21 in. Front length, 42 in. from waist; side piece, 43 in. Second side piece, 44 in.; back, 45 in.; sleeve from centre back to elbow, 20 in.; elbow to wrist, 10 in. Working scale half chest, 17 in.; $\frac{1}{4}$-in. turnings are allowed on all seams.

Drafting. For the system, see **58**, page 1841.

Two large sheets of paper are required, also a long rule or blind lath, and an inch tape.

First square the lines A, B, C, D and E, as in previous draft [**67**].

D to 1, $1\frac{1}{2}$ in.; draw line from A through 1 to E; 1 to 2, $1\frac{3}{4}$ in.; make 3 in the centre of back line and C^a; and 4, $\frac{1}{4}$ in. to the left of 3.

C^a to I, $1\frac{5}{8}$ in.; F to I^a, $1\frac{5}{8}$ in. Raise J $\frac{1}{2}$ in. and connect to shoulder; J^b is in the centre; make a dot $\frac{1}{4}$ in. to the right of J^b. J^a to K, $\frac{1}{2}$ in. Raise H^a $\frac{1}{4}$ in., connect to M^a

Draw front shoulder line, make M^b in the centre. Curve the armhole from O to K. M^a to P, the length from nape to waist, omitting the back neck less $\frac{1}{2}$ in., *i.e.*, two seams (as from A to A^b). This should not be omitted, as it determines the waist, and is a most important measurement. Draw waist line from 1 to P.

SIDE PIECES. 2 to 5, $1\frac{1}{2}$ in.; 5 to 6, $2\frac{1}{2}$ in.; 6 to 7, $1\frac{1}{2}$ in.; 7 to 8, $2\frac{1}{2}$ in.; 8 to 9, $1\frac{1}{2}$ in. Draw line from 2 through 4 to J^b; from 5 through 3, $\frac{1}{4}$ in. to the right of J^b, and 6 to C^a.

Curve from 7 through C^a to K; from 8, $\frac{1}{4}$ in. to the left of I^a, and from 9 to I^a.

DART. Make 10 in the centre of 9 and P. Measure the waist as in previous lesson, and put the amount left over in one dart; in this case it is $2\frac{3}{4}$ in. Make 11 $1\frac{3}{8}$ in. to the left of 10, and 12 $1\frac{3}{8}$ in. to the right. Now make a dot $1\frac{1}{2}$ in. to the left of G. Draw a line from the dot through 10 to the bottom of garment. Curve from 11 and 12 to within 2 in. of bust line, and slightly curve from thence to M^b.

SKIRT OF ROBE. Make dots in the centre of 6 and 7, and 8 and 9. Square down from the centre of dart and each dot, and make dots on the seat line. Make dots $\frac{1}{4}$ in. to the left and right of centre dart and curve upwards from the dots to 11 and 12.

13 is 1 in. to the right of next dot on seat line; 14, $1\frac{1}{4}$ in. to the left; 15, $\frac{1}{2}$ in. to the right of next; 16, 1 in. to the left.

Square down from centre of 2 and 5 to seat line; make dot, place 17 and 18 $\frac{5}{8}$ in. to right and left of same. Make a dot $\frac{1}{2}$ in. to the left of E. Curve from 14 to 9, 13 to 8, 15 to 6, and 16 to 7. Draw lines from 18 to 5 and 17 to 2.

FRONT. P to P^a, 42 in.; 11^a and 12^a are $\frac{1}{2}$ in. to the left and right of centre of dart. Connect these to the dart on seat line. Place the ruler on 9 and 14, draw a line to the bottom of garment.

Now take an inch tape and measure from 9, round the curve through 14, and make 14^a 1 in. longer than front, *i.e.*, 43 in. Draw line from 14^a to P^a.

UNDER ARM. Place the ruler on 9 and 13, draw line to the bottom. 8 to 13^a is the same length as from 9 to 14^a (43 in.).

Place the ruler on 7 and 16, draw line to the bottom; measure from 7, and make 16^a 1 in. longer than from 8 to 13^a (44 in.). Connect 13 to 16^a.

SIDE PIECE. Place the ruler in the centre of 6 and 7, with the edge resting on 15; draw line

to the bottom, make 15^a the same length as 7 to 16^a (44 in.).

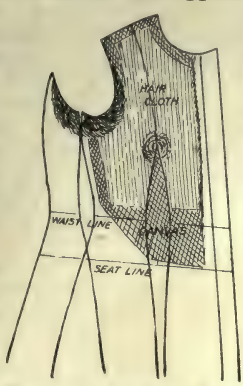
Place the ruler on 5 and 18, draw line to bottom, make 18^a 45 in.; connect 18^a to 15^a.

BACK. Place the ruler on 2 and 17, make 17^a 45 in. Place ruler on 1 and the dot to left of E; make E^a 45 in. Draw line from E^a to 17^a.

For sleeve draft, see **59**, page 1842.

If the material is not wide enough to cut the fronts without joins, 3 in. can be taken off the gore gradually to seat line. If this is done, the 3 in. must be divided and put on the left side of the two gores, and taken gradually to seat line [see broken lines].

Materials Required. 4½ yd. of 54-in. material will be required, or 8 yd. single width, and the same quantity of lining; ¾ yd. of the finest French canvas (it must on no account be a heavy make); 10 strips of whalebone (not composition), 8¾ in. long, or according to length required, for button and buttonhole, or 12 for edge to edge fastenings; ½ yd. linen.



69. LEFT FORE PART OF GOWN

Trace and cut out the linings the same as material, but ½ in. extra must be allowed on the turnings.

The Making. Before beginning to make the robe the reader should turn to LADIES' TAILORING, page 1840 etc., as, with a few exceptions, which we shall give, the making, pressing, and shrinking will be practically the same as in the ladies' tight-fitting jacket.

Take the left fore part, baste the dart down from M^a to 11^a and 12^a. When stitching, keep ¼ in. outside 11 and 12, and taper to a point at the top; begin to stitch from bottom.

Cut through the dart, notch it on both sides at the top to make it lie flat, and pare the cloth away ¼ in. from the seam.

68. PRESSING PAD

Open and press the dart on a bare board. Now press the top of dart on the pressing pad [**68**], wrong side uppermost, and with a damp cloth over. Press from the side, front, and shoulder in towards the top of dart, to give a rounded appearance and to form a receptacle for bust.

It is most important that the canvas should be basted in with great care, so as to ensure the fore parts fitting well; to guard against this part of the work being a failure, the instructions which follow should be strictly carried out. First prepare the canvas—*i.e.*, shrink it as in previous lesson; cut it crosswise by folding at opposite corners and cutting through the fold.

Now cut it for the fore part, as indicated in **69**. Trace the dart, and cut away to within ¼ in. on either side. It is not necessary to stitch the dart; all that is required is that one edge shall overlap the other, and that the two be thickly serged together.

Nick the top of dart to permit of the edges overlapping without causing a fold in the canvas.

Now place the canvas on the table, lay the fore part on the top with the darts together evenly; baste down the centre of dart from the waist to the bottom, then from the waist to the shoulder.

Now baste all round, keeping the canvas easy both in length and width, particularly across the chest; this should be done by holding the fore part over the knee while basting. The darts must be secured together, but the stitches should not show on the right side.

The Hair Cloth. The hair cloth must also be on the bias, cut the same shape as canvas but smaller—that is, it must be 1 in. clear of the edge all round and 1¾ in. above the waist. It must be well basted to the canvas only as the stitches will remain in, and have a strip of linen placed over the edges as has been already described. The dart must be treated in the same manner as in canvas.

A round pad of wadding 4 in. in diameter must now be prepared for the top of each dart in this manner. It must be fairly thick in the centre, and thinned away towards the edges as evenly as possible, to prevent ridges showing through; it should then be stitched round and round from the centre to the edge to keep in position [**69**].

Well baste the pad, to the canvas only, placing the centre of pad to the centre of top of dart [**69**]. Proceed with the fore part as in previous lesson.

Continued

Group 24 PHYSICS 14 Continued from page 1900	THE PHYSICS OF HEAT

THE PHYSICS OF HEAT

Radiation, Absorption and Conduction of Heat. Thermodynamics. Theories regarding the World's End. Universal Death. Conservation of Matter

By Dr. C. W. SALEEBY

BRIEF reference has already been made to the fashion in which heat travels. We distinguished between *convection* and *conduction.** But heat may also travel, as everyone knows, by *radiation;* and the heat so conveyed we may term *radiant heat.* The sun gives us not only light, but radiant heat; so does a fire. As we sit in front of a fire we know that air intervenes; but we also know that the space between us and the sun is not filled with air. Radiant heat is conveyed by, or consists of, vibrations, not of the air, but of the *ether*—the so-called *luminiferous* or *light-bearing* ether. Now, as we shall see later, light and radiant heat are essentially identical; they both consist of precisely the same kind of vibrations of one and the same medium. The difference between them is the same as the difference between one octave of the keyboard of a piano and another. Thus the laws and the manner of the transmission of radiant heat are in every respect identical with those of the transmission of light.

Laws of Radiation. What must we conceive to happen as a hot body radiates heat from its surface? We conceive the heat of the body to consist of a form of motion. We must regard this heat energy, which is really kinetic energy, as being transformed, at the surface of the radiant body, into the energy with which the ether around it is caused to vibrate. When some other material body is struck by these rays, they are retransformed into the previous form of heat or into heat and light.

We have said that the laws of the transmission of radiant heat are those of the transmission of light. It is true of the waves of both that they are propagated strictly in straight lines. This can be proved for heat almost as easily as for light. Similarly, it is true for both, as, indeed, for all forms of ethereal wave motion, that the intensity of the radiation, or its energy per unit of its area at any point, varies inversely as the square of the distance from the source of the radiation. We may compare this law with the similar part of the law of gravitation.

The reflection of radiant heat, again, follows the same laws as the reflection of light—as we must expect, since we believe them to be essentially identical. Again, radiant heat and light are similarly subject to refraction, when passing through a solid medium, or from one solid medium to another.

"Transparency" to Heat. We purposely employ this unusual phrase in order to insist still further upon the identity of radiant heat and light. We know that exactly as substances differ in their transparency to light, so they differ in their transparency to radiant heat—a property which is technically known as *diathermancy.* Substances which are transparent to light are not necessarily transparent to heat, however. But this fact is only another aspect of the fact of light—that light waves of different wave length are variously transmitted or reflected by various material substances. Water readily transmits light, just as glass does, but it is quite opaque to radiant heat; whereas liquid bisulphide of carbon is highly "transparent" to radiant heat, transmitting nearly two-thirds of the rays.

A classical proof of the presence of rays of heat in sunlight, and their essential identity with those of visible light, is to be found by spreading out the various waves in sunlight into a spectrum by means of a prism. Everyone knows that in such a case we see a band of colours, shading off from red to violet. If, now, a thermometer be put in various parts of the spectrum, it is found to be heated in varying degrees; but in greatest degree when it is passed quite beyond the red end of the coloured band, and exposed to the invisible heat rays which lie there.

Absorption of Radiant Heat. Just as light may be absorbed and radiated, so may radiant heat, the rule being that the absorption and radiation of bodies with dull surfaces is greater than that of bodies with bright surfaces. It must be evident that as a body radiates, it cools. If its immediate surroundings were "opaque" to radiant heat, the body could not radiate and could not cool. Other things being equal, however, we may assert that the rate at which a body cools is proportional to the difference between its temperature and that of its surroundings—that is to say, if the difference be 20 degrees, the body will cool twice as fast as it would if the difference were 10 degrees.

The importance of radiation as a cause of cooling is most marked in the case of planetary bodies. Probably owing to its small size, the moon has been unable to retain its atmosphere; hence it has been able to radiate its own proper heat with great rapidity. Furthermore, while the heat upon its surface when exposed to the sun must be terrific, on the other hand, it must radiate away such heat at a very great speed when the sun is hidden from it, producing the most intense cold. The earth is always radiating its heat into space. So far as the usually recognised constituents of the air are concerned, this heat can readily escape, oxygen and nitrogen being *transparent* to radiant heat, or *diathermanous,* to use the technical term. But water vapour is a constant constituent of the atmosphere, and this, being relatively

opaque to radiant heat, arrests a great deal of the radiation. The reader who is interested in this subject must turn to the discussion of radium and radio-activity in the course on chemistry, since we now know that the radio-activity of the earth's crust is sufficient to compensate completely for the amount of heat which it constantly loses by radiation.

The Conduction of Heat. Of the convection of heat we need say no more than has already been said ; but the conduction of heat is a much more important matter. We are all familiar, in the first place, with the fact that the thermal conductivity of different substances varies within wide limits, metals being conspicuous instances of good conductors ; while most products of living matter, such as wool and bone and wood, conduct heat very badly. But metals themselves vary in this respect. We have noted elsewhere, for instance, that copper and silver are exceptionally good conductors of heat, as also of electricity. It is obviously necessary to invent a standard by means of which we may readily express the *thermal conductivity* of a substance. This, then, is defined as the number of thermal units which are conducted per unit of time per unit of surface through a slab of unit thickness, the sides of which differ in temperature by one degree. We cannot here wait to discuss the various experimental methods by which the relative thermal conductivity of different substances may be estimated.

The Results of Differing Conductivity. But, at least, we must spare space to note some of the most obvious consequences of the wide differences that obtain between various substances in respect of thermal conductivity. The most important of these results are those which affect the bodies of warm-blooded animals. Nearly all such animals are covered with a coat made of one kind or another of non-conducting substance. Feathers are of some value in this connection, hair of greater value, wool more valuable still, and fur most valuable of all. It is needless to say how animals in various regions of the world are adapted in these respects.

Man is conspicuous among warm-blooded animals in being naked, and finds it necessary to cover himself with substances having a very low thermal conductivity. The most valuable of these are all derived from the non-conducting coats of other animals. We speak of warm and cool clothing, but the reader is well aware that, according to the Laws of Temperature [see page 1563], all bodies tend to become equal, not in amount of heat, but in heat level. Thus all the various kinds of clothing are, in general, of the same temperature. What we call warm clothing is merely that which has a low thermal conductivity, or is a bad conductor ; while cool clothing is that which has a higher thermal conductivity, or is a better conductor. In this connection it must be noted that an important part is played by the air which our clothing confines. Loose clothing is far warmer and in every way better than tight clothing of the same weight and material. By means of loose clothing we are covered with many broken layers of air—air which soon comes to have the same temperature as the body, and which also tends to be saturated with water vapour. Such air must thus necessarily tend to arrest radiation and evaporation—two of the most important means by which the body tends to be cooled.

The Safety Lamp. Everyone who has spent even an hour in a laboratory must be familiar with the experiment of controlling a flame—such as the flame of a Bunsen burner—by means of a sheet of wire gauze. Such gauze may be made to confine the flame beneath itself ; while, on the other hand, if the gauze be held an inch or two above the burner before the gas is ignited, the gas can be made to burn above the gauze, but the flame will not spread beneath it. The obvious explanation of this is that the metal of the gauze is a good conductor, and so rapidly carries away the heat produced that the temperature on the far side from the flame (whichever that be) is not high enough for the combustion of the gas. This fact is utilised in the famous safety lamp invented by Sir Humphry Davy. This is simply an oil lamp surrounded by a cylinder of wire gauze. If coal gas be present in the air of the mine, it will burn when raised to an adequate temperature by means of the flame of the lamp ; but the gauze will prevent the flame from spreading beyond it, while the harmless burning of the coal gas affords an important warning to the miner.

Heat and Work. We must now pass to consider what is, in some respects, the most important aspect of the science of heat. We are already agreed that heat is not a material thing, not a fluid, or a *phlogiston*, but a mode of motion—a form of energy convertible into any other form of energy, as in an engine or an animal body. In many ways we can produce heat by doing work, as in every kind of machine, or as in the case of a savage who lights a fire by rubbing two pieces of dry wood together. Now the question arises whether there is a definite amount of heat that corresponds to any particular amount of work done ; and the answer is that such a definite and necessary relation does exist. The famous name in this connection is that of Joule, of Manchester, and his work is about 60 years old.

The *mechanical equivalent of heat* is now frequently represented by the letter J, and this has been variously estimated since the time of Joule. We may say that the mechanical equivalent of one British unit of heat (the amount of heat which can raise one pound of water from 60° to 61° F.) is 778 foot-pounds. The establishment of this equivalent—or, rather, the establishment of the fact that there is an equivalent—leads to the foundation of the science which is now known as *thermodynamics*, and which deals with the relations between heat and kinetic energy. It is largely the study of this science which has led to the establishment of the great principle of the conservation of energy, which we must shortly consider.

Laws of Thermodynamics. In accordance with this principle, what is known as the *first law of thermodynamics* states that *the amount*

of heat evolved in doing a given amount of work—assuming that the work results exclusively in the formation of heat—*is constant ;* and, on the other hand, that *the consumption of heat in producing mechanical energy is equally constant.* We have already stated the figure which expresses the relation between heat and work. So far as the first law of thermodynamics goes, there is absolute and reversible equivalence between heat and work ; but to it we must add a *second law of thermodynamics,* which states, as we already know, that heat cannot pass from a body at a lower temperature to one at a higher. Hence, we have a new significance for temperature or heat level. You may have heat enough and to spare, but unless you have a balance of temperature in your favour, you will never get any work out of it. Thus, while the first law of thermodynamics expresses the conservation, equivalence, and convertibility of energy, the second law expresses what we may call the doctrine of the *availability of energy.* This second law (as well as the first, in some small measure) we owe to the genius of Lord Kelvin, formerly Sir William Thomson. The years 1851 and 1852 saw his contribution to the Royal Society of Edinburgh of the two classical memoirs in which the science of thermodynamics is put upon a firm foundation.

Lord Kelvin. At this point we cannot do better than quote from Dr. J. T. Merz, whose " History of European Thought in the Nineteenth Century " is the most valuable work of its kind in any language. He says : " It was Thomson who first clearly saw that the axiom of the impossibility of a perpetual motion would be infringed if the first law of thermodynamics—the indestructibility of energy—was accepted without the second. For practical use, for doing work, it is not sufficient that energy be not lost ; it must be available—get-at-able. Energy may be in a condition in which it is useless—hidden away—and to bring it forth again may be for us either impossible (if it be dissipated), or may require an expenditure of work—*i.e.,* of energy—to do so." But to this subject we must return after we have discussed the great generalisation of the conservation of energy, to which the first law of thermodynamics affords such signal support.

The Conservation of Energy. The doctrine of the conservation of energy has well been described as the greatest of all exact generalisations. The idea is far older than its proof. Indeed, the philosopher Thales, as long ago as 600 years before Christ, said—or, at least, is reported to have said: *Ex nihilo nihil fit—i.e.,* " from nothing, nothing is made." This, however, is only one-half of the doctrine, being the other half to that which is alone expressed by the usual name of the doctrine. On the one hand, the doctrine denies *annihilation,* declaring that energy is persistent and conserved ; and, on the other hand—as in the saying we have quoted—it denies *creation.* These two denials are equally essential and complementary parts of the doctrine.

Now, the reader who remembers our discussion of Newton's laws of motion cannot but observe how consistent those laws are with the doctrine of the conservation of energy—in this case kinetic energy. The word energy was introduced by Dr. Young at the beginning of last century, but the idea which it conveys was more or less definitely present to the mind of Newton himself ; and Lord Kelvin and the late Professor Tait have shown in addition that Newton was on the very verge of recognising completely and formulating the modern doctrine of the conservation of energy. Notably, we may remind the reader of the simple expression of his third law, that *action and reaction are equal and opposite.*

Perpetual Motion. The laws of thermodynamics teach that while energy is always conserved, it is capable of endless and indefinite transformations—as, for instance, from heat into work or vice versâ. Now all the workers—French, German, and English—whose labours went to consolidate the science of thermodynamics used language which was incompatible with the old idea commonly known as *perpetual motion.* The phrase is an unfortunate one, since the universe must in all probability be regarded as itself a perpetual motion machine ; but by the impossibility of perpetual motion is really meant not a denial of Newton's first law of motion—that is to say, the doctrine that all motion is perpetual until force interferes to alter and modify it—but rather the principle that such a perpetual motion is of no use, since no work can be done with it except by using it up or annihilating it. And this statement reminds us of the second law of thermodynamics. It was all very well to assert—as various workers did assert in the 'forties of last century—that power cannot be created or destroyed, and that its various forms are mutually convertible without end, but such assertions are equivalent to saying—are they not ?—that perpetual motion *is* possible.

Energetics. It was Lord Kelvin who first recognised " that the old phantom of a perpetual motion was turning up again in a new form." Thus we must never remember the doctrine of the conservation of energy without also recalling the subsequent doctrine that though energy is never *lost,* it becomes for our practical purposes *unavailable.* Hence the great German scientist, Professor Ostwald, in framing the terminology of the science which he calls *energetics,* describes the doctrine of the conservation of energy as the first law of energetics, and then goes on to say: " A perpetual motion could, however, be attained if it were possible to induce the large store of energy at rest to enter into transformations." The fact that this is impossible Ostwald calls the second law of energetics. We may associate it in our minds with the second law of thermodynamics already stated.

Dissipation of Energy. So far as the law of the conservation and the equivalence of the different forms of energy is concerned, it would appear that these are all of the same value. When work is done no energy is consumed—it is merely changed. Why may it not be changed back again ? So far as the law of the conservation of energy is concerned, all

natural processes—all mechanical processes at any rate—must surely be reversible. But Lord Kelvin showed that this is not so. In 1851 he said—and this is practically his second law of thermodynamics: "It is impossible by means of inanimate material agency to derive mechanical effect from any portion of matter by cooling it below the temperature of the coldest of the surrounding objects."

Available and Unavailable Energy. Thomson saw that, notwithstanding the work of Joule, natural processes do not work as well backwards as forwards—in other words, the *Cosmos* is not a perfect machine, if even it be a machine at all. He realised that there is in nature a general tendency towards, not a destruction, but a degradation or dissipation of energy. The energy is not lost, but it is lost so far as its utility is concerned. All forms of energy tend to assume the form of heat, which is the least available form of energy. For all practical purposes, and also for our philosophical view as to the future of the universe, the distinction between available and unavailable energy, or between useful and useless energy, is all-important. Other workers showed that in practically all natural processes a certain quantity of energy is thus accumulated and lost. This energy was called *entropy* by Clausius, who introduced that much controverted term; and what Lord Kelvin had expressed as the universal tendency in nature towards the dissipation of energy, Clausius expressed by saying "the entropy of the world is always on the increase."

The Coming of Universal Death. But what does this signify if we take a large enough view of it? It signifies that the universe is travelling towards universal death. It makes us think of the universe as resembling a clock or watch, made and wound up once and for all, and destined ultimately to run down and stop. It seems clearly to imply a beginning, and, as clearly, to imply an end. At present there is a great difference of heat potential between the different parts of the solar system, one consequence of which is the presence of life upon the earth. But in time to come the heat will have distributed itself so that the system which corresponds to the solar system of to-day will be all of one temperature, and life will be impossible. The case must be the same, if Lord Kelvin's doctrine be correct, with the whole universe. In time it will all have assumed a uniform temperature; its other forms of energy will have been resolved into heat, and the cosmic life will have run its course.

Furthermore, since natural processes are irreversible, there must be no possibility of a phœnix-like resurrection. "This remarkable property of all natural processes," says Dr. Merz, "seems to lead us to the conception of a definite beginning and to shadow forth a possible end—the interval, which contains the life or history of nature, being occupied with the slow but inevitable running down or degradation of the great store of energy, from an active to an inactive or unavailable condition." The recent discovery of radium and radio-activity, and of all the hitherto unsuspected energy—available energy, too—which these reveal to us, does not militate in any degree against the doctrine of the dissipation of energy. These discoveries may show that the "watch" will run for millions of ages longer than we had thought, but they do not affect the apparent fact that it *is* running down.

Doubt of the Issue. Almost overwhelming as the evidence for this doctrine would appear to be, it is yet very far from being accepted by contemporary physicists. It is not, indeed, accepted without grave reservations by Lord Kelvin himself. If, for instance, we regard the universe as a closed system, one conclusion emerges, and, if not, another emerges. We do not in the least know what is the destiny of the heat and light energy which are incessantly being radiated from the solar system. When the doctrine of the dissipation of energy was framed, there was scarcely any conception of the idea, now current amongst astronomers, that the universe—or, rather, *our* universe—may be finite. We are now entitled to suggest that even if *our* universe be running down, something may be going on elsewhere which shall wind it up again. From the doctrine of the conservation of energy there is no escape; it has survived even the revelations of radium. But the doctrine of the dissipation of energy must not be regarded as more than an extremely important proposition which demands further consideration.

The Conservation of Matter. As the reader of the course on Chemistry has already learnt, the doctrine of the conservation of matter can no longer be maintained, at any rate, in its original form. But the doctrine of the conservation of energy stands—"this grand principle," as Professor Tait used to call it. Recognising that the law of the conservation of matter must really be regarded as only an aspect of the law of the conservation of energy, Herbert Spencer formulated, nearly half a century ago, the phrase *persistence of force.* But force, as the reader knows, is a term now used in a special sense by the physicist, and so Spencer's term has not gained currency. Quite recently, Professor Haeckel, of Jena, included the doctrines of the conservation of energy and the conservation of matter under the term, the *law of substance*—meaning by substance the thing that stands under—the underlying something. This is really another name for Spencer's persistence of force. If now we turn back from Spencer to Thales, whom we have already quoted, we see the importance which philosophers have attached to the conception that there is at bottom some kind of reality which is eternal, and which, however many transformations its appearances may undergo, suffers neither increase nor loss.

Our Conclusions Summarised. Here we must conclude the most fundamental and philosophically important part of our subject. The great truths which we have learnt so far may thus be summarised. We have learnt to

suspect that causation is universal; we have learnt to recognise the equivalence, the capacity for transformation, and the ultimate identity, of many things which appear to be different. (Our coming study of sound and light will add to the number of these.) We have learnt, that is to say, to recognise unity in multiplicity, ultimate identity in apparent variety. We have learnt to question the possibility of annihilation or of creation out of nothing. We may even be inclined to admit that these processes cannot really even be conceived. We have seen how, within the last hundred years, physicists have placed upon the foundation of observation and of exact experiment this doctrine, *Ex nihilo nihil fit*, which was first framed, and has been for ages maintained, not on the grounds of any observations or experiments whatever, and in contradiction, indeed, of appearances, such as those of apparent destruction by fire—but which was, in the first place, based upon a law of the mind, which compelled it to believe that something could not be created out of nothing nor ever reduced to nothing. This part of our subject has therefore led us to the confirmation of an *à priori* or necessary truth by the special method which is characteristic of science, and which is known as the *à posteriori* method of reaching general from particular truths.

Physics and Materialism. Lastly, our study of energy as essentially the only external reality, has endowed us with an effective weapon against materialism. It must also have suggested to the most thoughtful of us the limits and partial character of the human understanding, of which there is no more striking feature than this: that it is almost compelled to think in the terms and conceptions of materialism. Directly we come upon such a conception as this of energy, we find it impossible to form any adequate conception of what it is *in itself*. Many of its appearances or manifestations we know, but only through them do we know it, nor do they guide us to any clearer conception than that it is an underlying Power. If we attempt to clear up this conception, we find that it either resolves itself into a material conception, or else is lost in a mist of words. But however imperfect our ultimate conception of energy may be, physics has performed an incalculable service for philosophy in framing the conception at all, and in showing how all things—even including matter itself—conform to it. Well may Bacon, the founder of the scientific method, in his masterpiece, the "Novum Organum," call natural philosophy—by which he meant Physics—the "Great Mother of the Sciences."

Sound. We must now pass to a new and very different aspect of our subject. The science of sound or *acoustics* (from Greek *akouo*, I hear) has no direct bearings upon philosophy nor upon any of the ultimate questions of physics. In this respect it is notably distinguished from the study of heat, and still more from *energetics*, or the study of energy. But, on the other hand, acoustics has a very special interest of its own for us, who are trying in the SELF-EDUCATOR to discover and recognise the unity of all things, and the manner in which each of the sciences bears upon all the others.

The study of sound is of the greatest interest for the psychologist, since sound and hearing must be studied together, and it is also of very great interest in relation to a science or department of science which is only nowadays beginning to be recognised and placed upon secure foundations—*viz.*, *æsthetics*, or the science of the beautiful and of the affecting elements in all the various kinds of art. In the following study of acoustics, then, we shall strive to recognise the fact that this subject is important not only on its own account, but also because of the light which it throws upon other studies of still greater interest and subtlety.

Methods of Studying Sound. Our first need is identical with that which we recognised when we began the study of heat. In that case we saw that the study has subjective and objective aspects. Subjectively, we said, we are familiar with sensations of heat and of cold, but directly we attempt to analyse the facts we observe that these sensations are in ourselves, and are due to external causes, which can be sharply distinguished from the sensations.

Substitute *sound* for *heat and cold*, and this sentence remains true. Just as in the discussion of heat we must not mix up psychology and physics—until, at least, we know which is which. Our present concern, as students of physics, is not with sensations but with the external objects or facts which cause them—that is to say, we are dealing with sound as an objective thing, and for the present it would be all one to us if our bodily organisation were altered, so that, as might quite well be, sound were visible or palpable or odorous or sapid instead of being audible.

Continued

1. Dinosaurian Reptile (*Diplodocus Carnegii*), from Upper Jurassic of Wyoming. Total length, 84 ft. 9 in. Length of head and neck, 23 ft. 3 in.; body, 12 ft. 4 in.; tail, 49 ft. 2 in. 2. Great Toothless Flying Reptile (*Pteranodon Occidentalis*), from the chalk of Kansas. Stretch of wings, 18 ft. 3. Fish Reptile (*Ichthyosaurus Intermedius*), from Lower Lias of Street, Somersetshire. Length. 9 ft. 4. Prehistoric Elephant (*Mastodon Americanus*), from Pleistocene of Missouri. Length. 20 ft.; height, 9 ft. 6 in. 5. Giant Ground Sloth (*Megatherium Americanum*), from pampa at Buenos Ayres. Height, 12 ft. 6. Turtle Reptile (*Plesiosaurus Cramptoni*), from alum shale, Upper Lias, Yorkshire. Length, 22 ft. [See GEOLOGY]

EXTINCT MONSTERS OF EARLIER AGES

[From the collection in South Kensington Natural History Museum]

THE EARTH'S GEOLOGICAL RECORD	Group 14 GEOLOGY 12
Non-sedimentary Rocks. The Geological Record of the Earth's Development. The Story of the Strata. Chronology of the Earth	Continued from page 1925

By W. E. GARRETT FISHER

IN order to complete our survey of the rocks which compose the visible portion of the earth's crust it remains to consider the non-sedimentary rocks, which form a very noticeable, though not by any means the larger, part thereof. These are the igneous rocks which come to the surface in parts where for various reasons the later sedimentary rocks have not been deposited above them, or have been entirely worn away by denuding agencies, leaving the bare, igneous rock cropping out, as in the granite tors of Dartmoor or in the volcanic sill which forms the Salisbury Crags in Edinburgh [**78**].

Non-sedimentary Rocks. These igneous rocks, as we have seen, are known as *plutonic* or *volcanic*, according to the manner in which they were originally formed. The plutonic rocks are those which were originally formed deep beneath the surface of the earth, and have since been revealed by the removal of the overlying strata. The volcanic rocks are those which have been brought up to the surface by hypogene activity, and have frequently been arranged in stratified sheets, often alternating with the true strata produced by epigene agencies. Of course, there is no absolute distinction between these two classes of rocks, since the volcanic rocks which appear on the surface must obviously be connected with the plutonic rocks remaining in the subterranean reservoir. But it is usually thought convenient to distinguish between volcanic and plutonic rocks, which, indeed, show somewhat different characteristics.

Plutonic Rocks. The plutonic rocks with which we are here concerned have usually been thrust up from the lower parts of the earth's crust by hydrostatic pressure, have been intruded into other rocks of more ancient formation, but have solidified beneath the surface of the earth, and therefore under considerable pressure. The fluid masses which were thus squeezed upward from the lower or molten parts of the earth's crust naturally took the line of least resistance, and the various shapes into which they expanded depended on the local conditions. We now find them mainly in one of four distinct formations—as *bosses* [**79**], or shapeless lumps of rock, often many miles in extent; as *sills* [**78**], or flat and roughly horizontal sheets of rock; as *dykes* [**80**], or veins of rock which have filled up

78. SALISBURY CRAGS, EDINBURGH, SHOWING VOLCANIC SILL

the cracks or fissures in earlier formations; and as *volcanic necks*, which occupy the pipes and craters of ancient volcanoes.

There are many examples within our own islands of each of these formations. Vast intrusive masses of granite characterise the scenery of Dartmoor and the South-west of Scotland. The Salisbury Crags, beside Arthur's Seat at Edinburgh, consist of a thick sill of dolerite; another forms the rock on which Stirling Castle is built; while the great Whin Sill can be traced for a distance of 80 miles across the North of England. Veins or dykes of intrusive rock are often found on seashores, as at Elie, in Fifeshire, where the wearing down of the softer adjacent rock has left them standing up like walls. The mineral veins in which many ores are found are generally intrusive dykes which have been run into cracks in the older rock. The hardened lava plugs of ancient volcanoes form the conical hills which are so common in the South-east of Scotland, like Arthur's Seat, North Berwick Law, and Largo Law.

Volcanic Rocks. Volcanic rocks are distinguished from the plutonic formations by the fact that they are usually found with a kind of false stratification, in which the volcanic *lavas* and *tuffs* are found alternating with true sedimentary beds. It is easily seen how this state of things has come about. Volcanic action is seldom continuous; the eruptions are usually separated by long periods of quiescence. At each period of activity the volcano sends sheets of lava welling out in all directions from the vent. When the flow ceases, these sheets harden into rock. The ordinary atmospheric agents then set to work to cover this sheet of igneous rock with the débris of which we have seen all sedimentary formations to be composed. After this layer has attained a certain thickness, which depends upon the length of time during which the volcanic activity is suspended, a new eruption takes place, and a second sheet of lava covers the sedimentary formation, baking, hardening, and perhaps chemically altering it. Thus in the lapse of ages we get a characteristic piece of *volcanic stratification*, in which sheets of lava alternate with layers of true sedimentary rock. There is a very interesting illustration of such a structure near the mouth of the Severn, which in ancient times was a centre of considerable volcanic activity.

All that was said in a preceding section as to the curvature, tilting, crumpling, and dislocation of sedimentary rocks applies equally to igneous formations, which display well-marked examples of joints, faults, and cleavage planes, though the other division into strata, or bedding planes, which characterises the sedimentary rocks, is usually absent, and when present, as in the schists, has been produced by different agencies, generally those of subterranean heat and pressure due to gigantic earth movements.

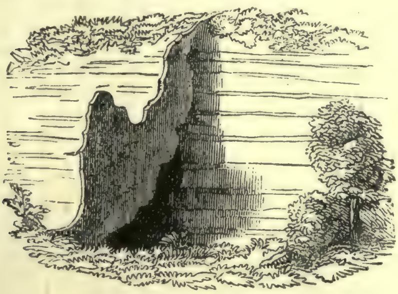
The Geological Record. We have now taken a general survey of the leading facts of geology. We have inquired into the existing structure and materials of the earth's crust, and we have examined the agencies which have brought about that structure and modified those materials. It now remains to see to what extent geology is able to trace the past history of the earth through the long ages during which these alterations have been taking place to produce our habitable earth. This record, though full of gaps and imperfections due to our limited opportunities of study, is written deeply upon the rocks, and has been read by geologists with wonderful precision.

Palæontology. The reader has already seen how the fact that the majority of superficial rocks are arranged in strata enables us to tell their relative age. Where we are dealing purely with sedimentary rocks it is quite clear that the upper strata must be younger than those that lie beneath them, and on the top of which they were originally laid down. There are some apparent exceptions to this rule—as when the strata have been so crumpled as to undergo actual *inversion*; when the oldest layers have been brought to the top, and might by a hasty observer be mistaken for the youngest; or when a mass of eruptive rock has been intruded into the midst of strata which are all really its superiors in age. To read this wonderful record with ease and accuracy requires the training of a lifetime; but the general results that it has yielded can be briefly explained. This geological record has a very important bearing upon the history of life. We have seen that the strata frequently contain fossil remains of the plants and animals which lived at the time when they were being formed. They naturally share the relative age of the strata which they inhabit, and thus we are able to discover the order in which the various forms of life have appeared upon the earth, and to provide trustworthy materials for the development of the great theory of organic evolution. This part of the subject, known as palæontology, lies really outside the scope of this course, and must be studied by the student of biology in the special articles on that subject. The geologist's share in the matter is confined to expounding the order in which the various forms of life have come into existence.

The Story Told by the Strata. It must not be supposed that the strata which make up the crust of the earth are everywhere arranged in the same order, or that the complete history of the rocks can be learnt by the simple method of boring into the earth at any convenient spot and tabulating the strata through which the shaft passes. The earth has so long been moulded by the agencies of change, which we have already studied, that the geological record has become extremely complicated, and it has required the labour of more than a century to elucidate its mysteries and entanglements. The work is something like that of the historical student who has to build up the coherent story of his chosen episode from books that he finds in the great national libraries of London, Paris, and St. Petersburg; dusty documents that he has to spell out in the London Record Office, among the archives of the Vatican, or the Royal Charters of Simancas. So the geologist reads one fragment of

story on the coast of Scotland, another in the gorges of Colorado, another in the mines of the Rand, and yet another in the contorted strata of the Andes. The whole thickness of the rocks that have been built up since the earth's crust first solidified amounts to many miles, and there is no place in the world where the whole vast series is conveniently displayed to the study of man.

The Chains of Geological Evidence. But everywhere the story is the same, and the fragments of knowledge which one geologist has won from his lifelong study of the Scotch granites dovetails in with that which another has obtained among the cañons of America. Everywhere it is found that there is a definite order in which the strata follow one another. There are often gaps and imperfections in the history of the rocks whereever we study them, but the gaps are never quite the same, and the knowledge which we gain in one locality helps to fill in that which is gained elsewhere. In this way it has been ascertained that there is a definite order of succession among the rocks now visible on the surface of the earth, and that this succession everywhere holds good. Thus, to take a simple instance, we find that the coal measures everywhere overlie the Old Red Sandstone, which is of earlier formation. In any part of the world we may find Old Red Sandstone where coal measures do not exist at all, or conversely we may find coal measures without the presence of the Old Red Sandstone. But we can say with certainty that wherever we find a layer of Old Red Sandstone, it is absolutely useless to bore through it in the hope of finding coal below. The value of such knowledge to the miner will be apparent; and it is never falsified.



80. DYKE

Chronological Classification of Rocks. The various stratified rocks which have already been described fall into certain series, each of which appears to have been formed at a definite time in the earth's history. Geologists are now pretty well agreed as to the main classification of these series, although there are still points of difference among them when it comes to minute detail. They all divide the rocks into five main divisions, each of which corresponds to a chronological epoch.

79. INTRUSIVE BOSS OF GRANITE

The oldest rocks of all, which were first formed when the crust solidified, are known as *Archæan.* Their successors, down to the rocks which contain the coal measures, are known as *Primary,* because they come first in the geological record; the later rocks, down to the cretaceous rocks which form the great chalk deposits of southern England, are known as *Secondary;* while the remaining rocks, which are of comparatively modern origin, are divided into *Tertiary* and *Quaternary.* Each of these periods is subdivided for convenience into a number of shorter periods of rock formation, which are known as systems, and it will be found that the rocks in each of these systems are distinguished by a certain number of common characteristics. The following table, beginning with the most recent, gives a brief summary of the various divisions and systems into which the rocks of our islands are divided.

THE ORDER OF THE STRATIFIED ROCKS.

Division.	System.	Typical Rocks.
Quaternary	Post-glacial or Recent	Alluvium and river gravels
	Glacial or Pleistocene	Boulder clay
Tertiary	Pliocene	Norwich Crag
	Miocene	Lacustrine deposits
	Oligocene	Isle of Wight fluvio-marine series
	Eocene	London clay
Secondary	Cretaceous	Chalk and greensand
	Jurassic	Portland stone and lias
	Triassic	New red sandstone
Primary	Permian	Magnesian limestone and sandstone
	Carboniferous	Coal measures
	Devonian	Old red sandstone
	Silurian	Slates and sand stones
	Cambrian	Welsh slates
Archæan	Pre-Cambrian	Gneisses and schists

Continued

Group 15
HISTORY
15
Continued from page 1940

THE END OF ROME

Rome under Titus. Destruction of Pompeii and Herculaneum. Hadrian. Marcus Aurelius. The Thirty Tyrants. Founding of Constantinople

By JUSTIN McCARTHY

VESPASIAN'S successor was his son Titus. This time there was no struggle for supremacy, and Titus succeeded as a matter of course. He had served with great distinction as a military Tribune in Britain and in Germany, and was left to conduct the war against the Jews after his father had been proclaimed Emperor. When he came back to Rome he shared with his father in the great public triumphs given to celebrate the conquest. The title of Cæsar was conferred upon him, and he took an active part, under Vespasian, in the administration of Rome. With the successes of his early life Titus combined a love of pleasure, and even actual dissoluteness, which had made many leading Romans doubt his fitness for the position of Emperor. But when he became invested with the responsibility of such a position, he showed himself capable of rising to a thorough appreciation of his duties, and of ruling the country with the genius of a statesman.

Rome under Titus. His career was an early Roman anticipation of that of Shakespeare's Prince Hal. Not only did he cast away all his habits of self-indulgence, but he showed himself genial and gracious in manners, and sympathetic with all who deserved sympathy. His subjects called him by the title "Delight of the Human Race," which had been given him by his admirers. It is told of him that he always regarded a day as lost in which he had not had the opportunity of doing a good action. His heart and mind were set on improving the condition of his people, or relieving the wants of all in distress, or spreading education, improving public and private morals by advice and example, and, according to his own phrase, on keeping his own hands free from human blood.

Fire and Plague. He completed the building of the Coliseum and built great public baths which were called by his name. Some heavy calamities visited the country during his reign—calamities of Nature which Titus did his best to alleviate. A great part of Rome was destroyed by one of those sudden conflagrations which from time to time broke out over the capital. A severe and widespread visitation of plague came almost simultaneously over many parts of Italy. At the opening of November, 79 A.D., a tremendous explosion of Vesuvius brought destruction on some of the neighbouring towns, amongst which Pompeii and Herculaneum were almost entirely destroyed by a flood of lava. Herculaneum had been severely injured by an earthquake fifteen years earlier, and it was almost altogether overwhelmed by this eruption of Vesuvius. The city was buried under masses of ashes and lava, and its actual site was only discovered in 1720, when the sinking of a well brought the workers to the remains of many of its buildings. A large part of its site had been covered by the successive building of villages on the new surface which the outpouring of ashes and lava had left. Pompeii was more fortunate than Herculaneum because it stood farther away from the burning mountain, and was covered not so much with the destroying lava as with ashes. The city was, however, completely hidden from sight for many centuries.

Pliny. Pliny the Elder, the celebrated scholar, naturalist, and historian, who was also a soldier, lost his life because of that memorable eruption. He had been put in command of the Roman fleet stationed off the coast near to Vesuvius. When the explosion broke out he was so anxious to study its phenomena that he landed on the shore, but had not gone far when the stifling vapours from the mountain overcame him. The ruins of Pompeii have been for generations one of the most interesting sights in Italy.

Among the latest benefactions rendered by Titus were those which he liberally bestowed upon the surviving sufferers from the Vesuvian eruption. Titus had become beloved and almost adored by his people, but he was not destined to reign over them for long. He died in September of 81, after a reign of a little more than two years, when he was only in his forty-first year. There were at the time suspicions, which historians have thought serious enough to record, that the early and unexpected death of Titus was brought about by poison, and was caused by the ambition of his brother Domitian, who was growing impatient for the succession.

Domitian and Nerva. Domitian succeeded at once to the throne. During the earlier part of his reign he pursued a course of moderation and justice; but when he undertook several campaigns, which were for the most part unsuccessful, he began to reveal the jealousies and passions that afterwards made his reign a calamity. He became jealous of the rising fame of Agricola, and recalled that great soldier to Rome from his military command; but that act, unjustifiable as it was, could not be compared for atrocity with many of his deeds of cruelty and oppression. We can read impressive descriptions of the worst chapters of his reign in the life of Agricola by Tacitus, while his vices and his wanton cruelties are pictured in the satires of Juvenal. His death was what might have been expected from his life. There were several conspiracies against him, and one proving successful brought him and his reign to an end.

Domitian was succeeded by Nerva. Nerva had won high reputation as a Consul, and his reign did credit to the choice which placed him on the throne. He was a man of great humanity

and enlightenment, who did his best to restore tranquillity, civil equality, order, and peace to the State which had so long suffered from rulers of a very different kind. One of his reforms was directed towards the repression of informers—men who made a living by inventing accusations against conspicuous personages, hostile to some powerful party, and either obtained a reward from those who were ready to welcome accusations against political enemies, or from the fears of those who were willing to pay a liberal bribe rather than brave the danger of being accused.

Accession of Trajan. Nerva was not endowed with much physical energy, and his reign only lasted for two years. He had adopted as his son and successor Trajan, who had made himself famous as a general in many wars, and who was conducting operations both civil and military in Germany. The news of Nerva's death and the news of his own succession reached Trajan at Cologne, where he was engaged in important work for the maintenance of peace along the frontiers, and the better discipline of the army. He made no haste to go to Rome, and spent some months over his work in Germany. Then he returned, and, according to his own desire, entered Rome on foot, with his Empress Pompeia Plotina at his side.

Trajan's accession was received with demonstrations of joy everywhere in Rome and throughout the Empire. Trajan was well qualified in appearance and bearing to represent the Imperial dignity. He began his reign as a reformer, and in certain paths of reform he remained consistent to the end. He greatly reduced the amount of taxation, and sold for the public benefit many palaces which some of the Emperors preceding him had obtained by confiscation. He employed much of the public money for the help of the poor, and especially for their children. He restored to the Senate much of the power which had been taken from it by some of his despotic predecessors, and revived the representative principle in the conduct of public affairs. He promoted public works partly as a means of finding work for the unemployed, the making of roads, the draining of marshes, and the creation of new seaports, some of which were created at his own cost.

Trajan and the Christians. He founded a great library and caused the erection of many splendid public monuments, among them the Trajan Column, which to this day symbolises his fame. Against his many noble qualities must be set his strong animosity towards the Christians, the persecution of whom he did not make any worse—for that would have been impossible—but which he did not mitigate in any manner worthy of his general character. He prohibited the hunting down of Christians as if they were wild beasts whom any citizen was entitled to discover and put to death, but when they made themselves conspicuous by teaching their doctrines he authorised the severest punishments of the criminal laws to be applied to them. Under his authority more than one Christian, holding high priestly office, was cast to the lions.

Trajan did not seem to be absorbed by a longing for war and conquest, and yet his reign saw as many military enterprises and invading expeditions as that of any Roman Emperor. Some of these he conducted himself. He created by conquest the Roumanian provinces, which still retain on the Danube the traditions of old Rome, and brought many Asiatic regions under the sway of Rome. Historians tell us he declared that if he were a younger man he would undertake the subjugation of the Indies. But his conquests were not, in most cases, of a lasting character. The vanquished races were always rising in rebellion against Rome ; the Jewish colonies were ever in rebellion and the closing part of Trajan's reign was stained with continuous bloodshed.

During the warlike operations which Trajan was conducting in the East, he was taken with sudden illness, and set out at once for Italy. He died on his way home in August, 117, after a reign of nearly twenty years.

Hadrian's Prosperous Reign. Trajan left no son to succeed him. His successor was Hadrianus, who in English histories is called either Hadrian or Adrian—usually the former. Hadrian had been approved by Trajan and by Trajan's wife, and it was in great measure owing to her influence that, when the succession became vacant, Hadrian was chosen Emperor. The new Emperor displayed many great qualities as a statesman. He abandoned as far as possible the policy of conquest in the East which so many of his predecessors had followed, and showed, indeed, little inclination for war. He endeavoured to secure Rome's possessions in Britain against the daring incursions of the Caledonians by constructing the famous wall from the mouth of the Tyne to the Solway Firth, some fragments of which still help to preserve his memory in those regions where Roman conquest is now but a tradition. The only fierce struggle that disfigured his reign and was encouraged and carried on by him was that against the Jews who would not sacrifice their religion to their Roman conquerors. Hadrian, although a man of enlightenment and of equity in most spheres of thought and action, was fiercely intolerant towards the Jews, and endeavoured to suppress by force their forms of worship and their sectarian ordinances. The result was a general uprising of the Jews in the Imperial dominions and a struggle lasting for nearly three years, in which more than 600,000 Jews lost their lives, while many who survived were sold into slavery. But for this dark stain upon its memory the reign of Hadrian was one of the most peaceful and prosperous in the history of ancient Rome.

Roman Art. Hadrian passed a great part of his life travelling through his dominions in order that he might acquire a close personal knowledge of their conditions, and of the improvements that might be made. He had a great love for Athens, which he often visited, and was thoroughly acquainted with the language and literature of Greece. He strove also to preserve peace with foreign States, and gave no encouragement to the national ambition

for conquest. Many public works of general utility were constructed during his reign, and he left to his country many splendid monumental records of his love for art and architecture. Some remains still exist of his abode at Tibur, sixteen miles north-east of Rome, where several exquisite specimens of Roman art have been discovered. A mausoleum Hadrian erected to receive his remains forms the groundwork of the castle of St. Angelo in Rome.

It would be gratifying to conclude the record of such a reign without disparaging comment. But the private life of Hadrian was sometimes disfigured by sensuality, and, while his rule was generally one of equity and humanity, he gave way occasionally to anger which displayed itself in summary acts of severity towards men accused of plotting against him, and to whom nothing like a reasonable form of trial was accorded. He died in 138, after a reign of 21 years.

Antoninus Pius. Hadrian was, during the latter part of his reign, much impressed by the high character of Antoninus, who had served as Consul with distinction. He sent him later into Asia to act as Pro-consul, and more lately adopted him as his successor because of the capability and virtue he saw in him. The choice was well justified. The year of his adoption was the year of Hadrian's death and the succession of Antoninus to the throne. He will always be known as Antoninus Pius, that honourable epithet being given to him because of the devoted tributes he paid to the name and fame of his great predecessor. He lived a temperate and unselfish life, was peaceful, public-spirited, and benevolent, and won the credit of having always acted as the father of his people. His reign will ever be remarkable for the fact that he was the first Roman Emperor who tried to put a stop to the persecution of the Christians.

Justin, who was known as Justin Martyr, a brilliant Stoic and, later, a Platonist who became converted to Christianity, was a conspicuous figure in the reign of Antoninus, and addressed to the Emperor his "Apologia" of the Christian Faith, the title of which is to be understood in the Latin, not in the modern English sense, for it was a vindication, not an apology. Justin afterwards earned the martyr's crown, but not until after Antoninus had passed away. The influence of Justin helped to strengthen his resolve to put some limit to the persecution of the Christians, who were already numerous and were ever increasing in numbers throughout the provinces and in Rome. Antoninus did his best to establish the principle of toleration for their doctrines, and to enforce on the magistrates and other authorities orders that Christians who had committed no crime against the civil laws should not be subjected to trial or punishment because of their Faith. It was to him that the noble saying that "The wealth of a prince is public happiness" was ascribed.

"Father of the Human Race." He took care that the finances of the State were administered with economy, and that means should thus be left him to help any region which might be visited by some sudden calamity causing sickness and poverty. His grateful people gave him the title of "Father of the Human Race." His reign was altogether peaceful, containing no record of war more serious than some expeditions for the suppression of disorders here and there on the frontiers. There were two conspiracies started against him by some of his enemies, for his toleration of Christianity was in itself enough to create enemies for him in those days. The conspiracies, however, were discovered in time, and thus came to nothing, and Antoninus, with his usual magnanimity, insisted that only the chiefs of these conspiracies, when tried and condemned, should be put to death. He died in his seventy-fifth year, leaving as his successor Marcus Aurelius, whom he had adopted, and who was married to one of his daughters.

Marcus Aurelius. Marcus Aurelius was called "The Philosopher," and his "Meditations" well established his claim to the title. He was tried by many severe troubles during his reign; there were incessant risings throughout the subjected provinces; there were devastating earthquakes in many parts of Italy, and a destructive pestilence raged for a long time in Rome. Marcus Aurelius sold the jewels and other treasures of his Imperial palace in order to meet the expenses imposed upon him by the wars and other calamities. He was indeed as innocent of any share in the creation of those wars as he was in the creation of the earthquakes and the pestilence, but he devoted himself as unsparingly to the mitigation of the one set of troubles as of the other. He had inherited from his predecessors those foreign conquests which brought about unceasing and, in most cases, justifiable uprisings of the native populations, and that inheritance brought with it his fate. He died near Vienna of an illness which came upon him while he was still prosecuting a war. The only cloud on the fame of Aurelius was that, unlike his predecessor, he encouraged the persecution of the Christians.

Commodus. Marcus Aurelius was succeeded by his son Commodus, who was but nineteen when he came to the throne in 180. He had served with his father in the war then going on, and as he had no inclination for military service he concluded a peace on almost any conditions, taking many thousands of his enemies into employment under the Roman Empire. This would appear to be magnanimous and statesmanlike conduct, but what we know of the general character of Commodus forbids us to come to any such conclusion. When peace was restored, and he returned to Rome, he soon became a sort of later Nero. He loved to show himself doing battle with wild animals in the Amphitheatre at Rome, and revelled in licentiousness of every kind. In one of his fits of what must be regarded as insanity he proclaimed himself to be Hercules, and demanded that his subjects should worship him. He was as cruel as he was profligate, and scattered death sentences so broadly against some of the noblest and best of his subjects, and even against some of his relatives, that it became impossible

for his rule to be longer endured. One of his favourites, with whom he quarrelled, and who believed that her life was not safe while he lived, formed a plot against him; and with the help of some men of influence who knew that they too were under his ban, had him strangled by a professional athlete.

An Empire at Auction. The authors of the plot immediately proclaimed Pertinax, Prefect of the city, Emperor. He was recognised by the Senate but was unpopular with the soldiers, who put him to death eighty-six days later. The next movement was that the soldiery, the most powerful body in the State, adopted a course which can best be described as putting the Empire up for sale by public auction. They made it known that the man who could best satisfy their demands, and especially who could offer the largest sum of money to the army, should have their choice, which meant, at the time, the election. The soldiers in and about Rome, by whom this astonishing proposition was made, chose their candidate because of his liberal promises; but two difficulties soon presented themselves in the way of his actual elevation to the throne. One of these was that the chosen candidate had not money enough in hand for the purpose of prompt and full payment; and while this difficulty was under consideration another arose. The arrangements thus far had been conducted by the army in and around Rome, but the Roman armies in foreign States refused to countenance such disposal of the Empire, each having a candidate of its own. The troops in Albania had Septimus Severus as their favourite, and he at once set out with a strong force of his martial supporters to advance upon Rome and claim his election. The senators, believing Severus the more formidable claimant, and therefore the candidate whom it was their interest to support, ordered the man already chosen to be put to death, and proclaimed Severus Emperor.

A Typical Roman Emperor. Severus proved to be a ruler of almost the typical order of rulers who left in Rome no noble memories behind them. Perhaps the one good thing that can be told of him is that he was careful and economic in his administration of the finances. He attempted some wars of conquest, and subdued rebellions in foreign settlements. In Britain he lost so many soldiers in struggles with the Caledonians that he found it convenient to raise a great wall of defence to shelter the southern regions according to the practical principle of Agricola. During some of his later wars he had a severe illness. He had two sons, one of whom is always known as Caracalla, although his real name was Bassianus. The popularly accepted title was only a nickname, as in the case of another Roman Emperor, because of a peculiarity in his dress—caracalla being the name of a Gallic garment which it was his custom to wear. The other son was Geta, and the two princes had already made themselves conspicuous by their incessant quarrels. It was commonly believed that Caracalla, growing impatient for his father's death and for his own succession, endeavoured to procure the assassination of the Emperor. It is at least certain that his illness suddenly increased in intensity, and he died soon after. We are told that the last words he spoke declared that he had been everything and had found that everything was nothing. Caracalla and Geta acted as co-regents for a time, and Caracalla was subsequently elected Emperor. His reign was one of cruelty and outrage; he had his brother put to death, and charged a large number of Geta's friends with having plotted with him against his own Imperial position; he further carried out a course of actual slaughter among all whom he suspected of participation in that conspiracy. More than 20,000 victims, it is declared, perished in this outburst of Caracalla's fury. Caracalla had six years of senseless cruelty until a centurion whom he had injured ridded the country of him.

An Ignoble Reign. The Roman Empire was now falling into utter confusion so far as its governing system was concerned. The Emperors were chosen by whatever part of the army happened to be nearest and most powerful when a vacancy occurred, and there were frequently several men at the same time claiming to be Emperor. Some of those who actually reigned were of the most ignoble character. Heliogabalus, who was now on the throne, gave himself up to the basest profligacy and lavish expenditure while indulging in the most whimsical eccentricities. He dressed himself as a woman, and established a Senate of women to help him in the government of Rome. Some of his soldiers at last rose against him and put him to death after he had reigned four years. Then his cousin Alexander Severus was made Emperor, and under his rule and his peaceful and noble guidance the Empire passed through some years of quiet and prosperity. Trouble, however, broke out in Persia, which involved a war with Rome. Severus was successful, but new troubles broke out in Germany, and Severus, who hurried to the command of the Roman legions, was killed near the Rhine.

The Reign of the Thirty Tyrants. The Empire, then, had six Emperors in rather less than nine years. There was a period known as that of the Thirty Tyrants, because Rome was under the dominion of a number of men—not, however, quite so many as thirty—who exercised a sort of contemporary military control, or military anarchy, over the Empire. Claudius, the most distinguished military commander then in the service of Rome, was elected Emperor in 268, but died soon after of pestilence while engaged in an expedition against the Goths. Aurelian then succeeded to the throne. Aurelian had great military capacity, and was, in many of his characteristics, superior to most of his recent predecessors, but his time was practically taken up in resisting invasions and in conducting expeditions for the suppression of invasion. He is best remembered

among modern readers because of his war against Zenobia, Queen of Palmyra, who is famous for her intelligence, her charms, her plans for the creation of a great Eastern Empire, and perhaps more than all else, because she had for her principal minister Longinus, author of the celebrated treatise " On the Sublime."

Longinus was a Greek philosopher and writer who had taught philosophy at Athens for many years, and afterwards went to the East and settled in Palmyra, where his merits were discovered by Zenobia, who made him first her teacher of Greek literature and then her chief minister. Zenobia had the bold desire to throw off her allegiance to Rome and make herself Sovereign of a great Eastern Empire, and in this she seems to have been encouraged by Longinus. She was, however, completely defeated, and had to fly from her capital in the hope of escaping her Roman pursuers, but was eventually captured and handed over to Aurelian. Aurelian kept her to grace his triumph in Rome. He spared her life and gave her a fine residence at Tibur, where she passed the remainder of her days. Longinus had been put to death on the capture of Palmyra.

Aurelian did his best to restore order in the government of Rome and discipline in the army, but he came to his end in the year 275, by the hand of his own secretary, who, being accused of extortion by his master, probably thought his only chance of escape lay in the assassination of the Emperor.

Rome's Decline and Fall. We need not follow minutely the history of Rome's decline and fall. The only Emperors who could be said to have deserved and maintained such a title were Diocletian and Constantine, one of the Sovereigns to whom the world has accorded the title of the Great.

The Roman Empire was fast going to pieces. Many of the foreign populations which Rome had conquered, and which constituted part of her dominions, had long been forming themselves into distinct nationalities, and were striving, with every prospect of success, to become separate and self-ruling States. In the East Rome was losing one after another the possessions on which she had lavished so much money and so much blood in making part of her Empire. The Britons, the Gauls, the Germans, the Spaniards, were becoming not only independent nationalities but dangerous neighbours. An immense change was coming over Europe and even over regions outside Europe by the growth of Christianity. The peoples who had become Christian regarded themselves as in direct opposition to the persecuting power of the Roman Empire, and were compelled by the progress of events and by the necessity of preserving their Faith to sympathise with every attempt to break down the domination of Rome. Even in Rome the Christians were now a powerful body, and were making converts daily among all classes.

During the days of Diocletian there were so many incursions of foreign races into the dominions Rome still claimed as subject provinces that Diocletian divided the government of Rome among four rulers, he himself being one. Each of these rulers had a different region to govern, and thus accustomed the Roman people to the idea of an Empire which did not have its seat of supreme and central government in Rome.

The Emperor Constantine. Constantine first distinguished himself as a soldier during Diocletian's reign, and became one of the Roman rulers when, after Diocletian's time, there had come to be no less than six Roman rulers at one time. There were incessant disputes and struggles among these rival potentates, but Constantine proved himself the strongest of any, became sole Emperor of the West, and finally supreme Emperor, bringing Rome back to the rule of one Sovereign just before her extinction as the great ruling power of the world. Constantine was much drawn towards the Christian Faith, and soon after becoming sole Emperor of Rome he issued a decree giving civil rights and full toleration to Christians throughout the Empire. It is told of Constantine by his biographers that in one of his military marches he saw in the sky a cross of light bearing the inscription which rendered into English is, " In This Conquer," and that the sight first filled him with the belief that the Faith typified by the cross must have a Divine origin. It is also told of him that in sleep he had a vision commanding him to inscribe on the shields of his soldiers the letters which constituted the sacred name of Christ.

Meanwhile he had resolved to remove the seat of Empire from Rome to Byzantium, in Turkey, for the reason no doubt that he believed Rome to have outgrown her power as a capital, and that her dominions could best be preserved by establishing a seat of Empire in some eastern city. He named after himself the city we now know as Constantinople, and lived there in peace for the remainder of his life. Before his death he received public baptism as a Christian. He died in May, 337, and with his death may fitly end the history of ancient Rome. From that time Rome ceased to be a ruling Empire, and a new world of Empires and of Republics, of progress and of civilisation, was coming into existence.

Continued

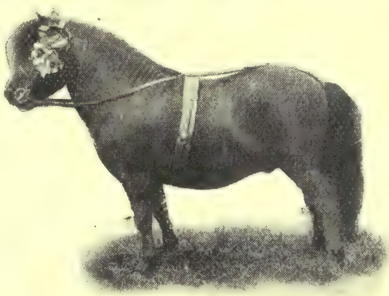
HORSES & THEIR MANAGEMENT

Famous Breeds. Rations for Horses at Rest and at Work. The Farm Horse. Care of Foals. Breaking in Colts. The Age and the Teeth

Continued from page 1971

By Professor JAMES LONG

Our Breeds of Horses—The Shire. This magnificent breed was formerly known as the Old English cart horse, and was practically made in the counties of Lincoln, Cambridge, Derby, and Notts, but it gradually extended to adjoining counties, and subsequently to every part of England. Since the establishment of the Shire Horse Society the Shire has become one of the most popular horses with farmers and landowners. It is chiefly black or dark brown, with white marks on the face and feet; bays are occasionally seen, but other colours are rare. It often reaches 17 hands in height, and in a good specimen the girth is from 7 ft. 9 in. to 8 ft. 6 in. While highly symmetrical in form, it may be described as "much in little." In build the Shire is square and massive, possessing a big chest, a short back, powerful shoulders and loin, long quarters, deep, well sprung ribs, muscular thighs, legs short below the knee, heavily clothed with fine silky hair or feather, and short pasterns. The head is long and fine, but broad between the eyes; the neck arched, and the feet large and wide; the lines of the body are highly symmetrical, while the weight of good specimens exceeds 2,000 lb. The Shire is a fast and active walker, and is largely bred by farmers, many of whom keep pedigree mares for the purpose, which they employ in their teams on the land. The produce is chiefly sold for heavy draught purposes to brewers, carriers, and the like. The Shire is perhaps the most powerful horse in the world. It is docile and intelligent, and is believed to have descended from the old English war horse, an animal of much smaller size. Great prices are often obtained for prize-taking stock, and, chiefly owing to exhibitions, the breeding of this animal has become an important industry. Pedigree stallions owned by wealthy landowners and farmers or hired by societies travel through most parts of England.



A SHETLAND PONY

The Clydesdale. The Clydesdale is the draught horse of Scotland, chiefly used for the heavy work on the farm and the drawing of heavy loads in the great centres of population. In colour it is usually dark brown or black with white markings; not quite so large as the Shire, it reaches a height of 16 to 16½ hands. While symmetrical in form, it is massive and powerful, possessing a gentle disposition and great activity for its size. The head is well formed, the neck arched and strong, the shoulders oblique, the back short and hollow, the chest wide and deep, the ribs round and well sprung, the quarters strong, the thighs powerful, the legs muscular and straight, and the bone, like the knee, flat, the pasterns sloping, and the feet broad and strong. The Clydesdale is a fast and free walker, and is on one side descended from stock imported from France.

The Suffolk. This variety, which is chiefly confined to East Anglia, is, on account of its heavy body and short limbs, known as the Suffolk Punch. Its colour is almost invariably chestnut, although varying in shade. It is active, courageous, and strong, walking and trotting easily; averaging about 16 hands in height, it sometimes reaches 16·2, and weighs from 1,850 up to 2,200 lb. The Suffolk possesses a neat head, a short neck, powerful shoulders, a well-rounded body or barrel, which is massive as compared with the legs which support it. The forearms are short and stout, the thigh muscular, while the legs are light in comparison with those of the Shire and Clydesdale, and carry no long hair. The pasterns are short and strong, and the feet smaller than those of other heavy breeds.

The Thoroughbred. The thoroughbred, or race horse, is the produce of our ancient native breed crossed with the Arab and other horses of Eastern origin. It is a somewhat nervous creature, exhibiting great speed, spirit, courage, and endurance. In build it is graceful, with fine skin, silken hair, and plenty of sinew. Under the management of a Royal Commission money is annually awarded to selected sires, which are distributed throughout the country for the use of farmers and others at low fees. The object is the production of hunters, carriage, and other saleable horses, which the thoroughbred is well adapted to produce when crossed on selected mares. The head, although wide in the nostril and the forehead, is fine, especially at the muzzle. The neck is long and slender, the shoulders long and black, the loin short, the quarters muscular, the legs long and flat, but short from the knee to the pastern, which is elastic, the forearm and thigh long, the chest high, and the constitution exceptional. In colour the thoroughbred is usually bay, brown, or chestnut, other colours being comparatively

rare. In height it reaches up to 17 hands; according to one of our best authorities, Sir Walter Gilbey, the height of the racehorse was 14 hands in 1700, 14·3 in 1800, and 15·25 in 1900.

The Cleveland Bay. This is an improving breed, which is bred in the Cleveland and adjacent parts of Yorkshire and Durham. It is employed on the farm for light draught work, for the saddle, and even for carriage work, the mares being specially adapted for the production of carriage-horses when crossed with the thoroughbred. In height it reaches from 16 to 16·2 hands, and its colour is the richest bay of any of our native breeds. The mane and tail are black, and the legs dark. The head is not well formed, but the neck and shoulders are well set, the latter sloping and powerful. The chest is deep, the back short, the barrel round, the loins powerful, the quarters long and especially well formed, and the legs clean.

The Coach Horse. Chiefly bred in Yorkshire, this variety has, like the Cleveland bay, to which it is closely allied, improved in form and quality owing to the establishment of a society. The mares are largely employed for the breeding of coach horses and hunters. In colour the coach horse is usually brown or bay with dark legs; the head is neat and the crest arched, the shoulders sloping, the loins powerful, the quarters symmetrical and strong, the legs flat, and the feet good. The coach horse has excellent action, and stands from 16 to 16·3 in height.

The Hackney. This is, perhaps, the most striking and popular of the light horses of British breed. Its stepping, its high action, and its speed in harness and saddle combine showiness with the usefulness of the horse. The Hackney is bred in almost all colours, although the chestnuts are the most popular. It stands over 15 hands, 15·3 being its outside height. The breed is the result of crossing—it has Arabian blood in its veins—and of selection. Its neck is of moderate length, shoulders deep and sloping, ribs nicely rounded, back short, fore arms short and strong, and hind quarters broad and muscular. The tail is placed high, and is invariably docked. The Hackney is altogether smart, spirited, and symmetrical. When moving, its action should be from the shoulder and not from the knee. The Hackney Horse Society, which has vigorously promoted the extension of this breed, the home of which may be regarded as Norfolk and Yorkshire, was established in 1883, and holds its annual show at Islington.

The Polo Pony. The polo pony is a wonderful production of the art of the trainer. Although the variety has scarcely become a definite breed, really good animals are remarkable for their speed, courage, stamina, and intelligence. The polo should not be under 14 hands. It may be of any colour, while its formation should be such as will enable it to accomplish its work most perfectly. Many crosses have been made in breeding, especially with the Barb and the thoroughbred, the former mated with polo mares being preferred by some authorities, who regard the Hackney as unsuitable for this purpose. There is now a Polo Pony Society, the work of which is telling on the breed.

The New Forest Pony. This pony, which may be of any colour, although usually black or brown, stands from 12 to 14 hands. It is a plucky, hardy breed, and may be regarded as the survival of the fittest, for large numbers of ponies have died in the Forest in the past, where they are frequently turned out for the whole winter. Useful animals may be obtained at the Lyndhurst and other annual fairs, but many are difficult to break.

The Exmoor Pony. Standing about 12 hands, the Exmoor pony is usually bay in colour, thickly built, strong, quick, short-legged, and provided with plenty of stamina. A really good animal is not common.

The Welsh Pony. The Welsh pony, standing from 12 to 13 hands, is a thrifty animal, varying in colour, duns being frequently met with, possessing sound, flat legs and good feet.

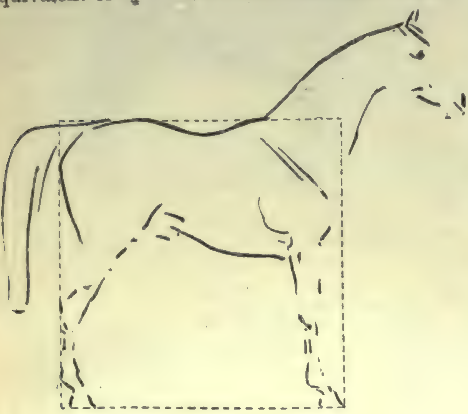
The Shetland. The smallest of British breeds is the Shetland, standing from 7½ to 10 hands high. It is short in the neck and back, gentle in disposition, furnished with muscular quarters and sound feet.

Methods of Feeding. Although horses are kept by all sorts and conditions of men, feeding is generally practised upon very similar lines. The most popular foods in the British Isles are hay and oats. There are, however, wide differences in the quality of these two foods as employed respectively by the costermonger and the huntsman. Good oats should be used, and they should be hard and thin skinned. Hay should be the finest early-cut mixture, containing a sufficiency of clover herbage, and it should be fragrant and sweet. Oats are preferably crushed for aged horses and horses with bad teeth, while the hay should be chaffed, the allowance never exceeding 12 lb. daily unless the circumstances are exceptional. Two or three pounds of sweet oat or wheat straw-chaff may be added to a day's grain ration in accordance with the size of the animal. Whether crushed maize, barley, malt, or beans, bran, middlings, or linseed meal or cake, or an occasional mangel or carrot, be added to the ration, depends upon circumstances, to which reference will presently be made.

Maintenance Ration. Food is supplied to the horse, first, for the purpose of maintenance, and next, for the purpose of providing for the energy expended in labour. A horse at perfect rest practically requires a maintenance ration only—*e.g.*, sufficient food to maintain the heat of the body and the wear and tear of tissue, without loss of weight. According to Zuntz, a horse weighing 1,000 lb. can be maintained on a daily ration of hay and grain which provides 6·4 lb. of digestible nutritious matter, of which not more than 3 lb. in the total ration should consist of crude fibre. Grandeau, whose experiments in France are so deserving of atten-

SOME FAMOUS BREEDS OF HORSES
1. Clydesdale 2. Cleveland Bay 3. Polo Pony 4. Moorland Pony 5. Shire 6. Suffolk 7. Hackney 8. Coach Horse

tion, experimented with three horses averaging 852 lb. in weight, which he maintained upon 17·6 lb. of hay daily, of which, on the average, 6 lb. were digested by each, this being the equivalent of 6¾ lb. for a horse weighing 1,000 lb.

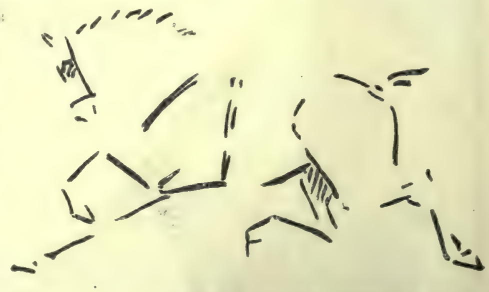


A WELL-FORMED HORSE
His height equal to his length. Note the dotted lines forming a square. (From Captain Gomme's "Hints on Horses": Murray)

Wolff found that a horse at rest weighing 1,100 lb. required 7¼ lb. of digestible matter excluding fibre, this, too, being equal to 6¾ lb. of fibre-free food for a horse weighing 1,000 lb. It should be pointed out that horses digest coarse fodder less perfectly than cattle and other ruminants, so that, although they require less for maintenance purposes, they need about the same quantity for this reason. Jordan accepts a daily ration of 6·6 lb. of digestible nutritious matter for a resting horse weighing 1,000 lb., and suggests among other formulæ, 10 lb. of hay and 5 lb. of oats, or 12 lb. of hay and 3½ lb. of bran, or 3 lb. of oats, or 2½ lb. of cracked maize.

Feeding the Working Horse. We have seen that a horse of given weight can be maintained when at rest on some 6½ lb. of digestible matter—*i.e.*, on that portion of the dry material of food which is nutritious and digestible, this being regarded as the maintenance ration. What the feeder next requires to know is what additional quantity of food should be provided for the accomplishment of a given amount of work by a horse of given weight. When we speak of food in this connection we mean the digestible portion of the additional ration provided. An addition to a ration having been made, it is important to understand, although the fact can only be approximate, what it means when translated into energy; nor must we forget that energy is expended as well when the animal moves itself as when it is moving its load. Let us again refer to the work of Zuntz, who found that about a third of the total energy provided by food could be utilised in the form of labour. This experimenter points out that a horse weighing 1,000 lb. when walking a mile at the rate of from two to three miles an hour would "expend a total energy of 473 foot-tons, 44·4 per cent., or 201 foot-tons of which belong to the effort of walking over and above the energy needed for mere maintenance."* Thus, although we can only regard the results as approximate, in walking and drawing a load 20 miles, the labour performed would be equivalent to the lifting of 9,300 tons one foot. In feeding a horse it should be remembered that speed tells as well as weight. Thus, a fast draught horse expends more energy is accomplishing the same amount of work than a slow draught horse, and consequently it requires more food, although, let us remark in passing, the additional food supplied for the accomplishment of additional work should be rather in the form of grain than of hay, a large quantity of which is not adapted to the limited capacity of the digestive organs of the horse. Many authorities regard 12 lb. of hay as a limit. This being so, it follows that the ration of a horse should be concentrated, well-balanced, and mixed with chaff, and supplied more frequently than in the case of ruminants.

The Food for the Fastest. A hackney or nag horse employed for any fast work requires more food, weight for weight, than a draught horse, more energy being expended in a given time. Thus, a hackney trotting 12 miles in an hour expends more energy than a draught horse, weight for weight, which takes three hours to cover the same distance with the same load, and consequently requires more food. The cost of horse labour increases with the speed with which it is performed. It is the pace that kills, quite apart from the increased consumption of food and wear and tear. In practice, however, horses kept for fast work are kept at rest during more hours daily than draught horses; consequently a balance is struck, the total food consumed is not materially increased, and time is given to the animal to recuperate. Farmers, as a rule, prefer fast horses on the land, but if such animals are worked the full complement



ACTION OF A HACKNEY HORSE WHEN TROTTING
(Captain Gomme)

of hours daily, they require more food than slower horses, and wear out more quickly. In the table which follows are some suggested rations for heavy horses.

The difference between the German standard and English practice, as shown by the rations given by farmers, and suggested by Fleming, is remarkable, but in practice there is just as

* Jordan on the Feeding of Animals.

RATIONS FOR HEAVY HORSES.
(Per Cent.)

	Dry matter.	Albuminoids.	Fat.	Carbohydrates.	Ratio.
Horse at heavy work, weighing 1,000 lb. (Wolff)	25·5	2·8	0·80	13·4	1–5·5
Do. moderate work .	22·5	1·8	0·60	11·2	1–7
Heavy horse at regular work (Fleming). Oats, 18 lb.; beans, 2 lb.; hay, 18 lb.; straw-chaff, 2 lb.	32·8	3·1	1·05	16·5	1–5·9
Farmer's summer ration (McConnell). Oats, 10½ lb.; beans 2 lb.; chaff, 2 lb.; grass, 100 lb.	34·8	3·4	0·9	18·6	1–6
German standard for a horse weighing 1,000 lb., in moderate work	—	—	11·4	—	—
Do. in average work	—	—	13·6	—	—
Do. in heavy work..	—	—	16·6	—	—

much difference in the weight of the rations supplied by farmers themselves. In many cases meadow, mixed, or clover hay are freely supplied, apart from the chaff used in mixing with the corn, while the oats provided on one farm may reach three bushels per week and on another only two bushels. Much depends upon the weight of the horses, upon the condition in which their owner prefers to keep them, and upon his particular views as to what constitutes a sufficient ration.

Proportions of Food. A French observer of wide experience finds by direct experiment that a draught horse in ordinary work requires 12 lb. of digestible dry matter per 1,000 lb. live weight, the proportion of fatty matter increasing with size. On the basis of the argument of Zuntz, if we assume that 6½ lb. of dry digestible matter are required for the purposes of maintenance of a horse of 1,000 lb., some 14 lb. of additional digestible dry matter would be required were such a horse engaged in walking with a draught of 1,000 lb. on a level road for 20 miles. We have seen that the ratio between the albuminoids of food on the one hand, and the fats and carbohydrates on the other, varies. Experience suggests that with increased work the albuminoids should be increased, and consequently the ratio reduced. It is for this reason that in heavy work beans are constantly added to oats, especially where such work is fast; but, inasmuch as the carbohydrates (sugar, starch, gum) and fats are chiefly employed in the animal economy in supplying the necessary energy, they may be provided in larger proportion for slow work, with the result that the ratio will be wider.

The employment of maize in the ration of a horse depends largely upon circumstances. It is inadequate for fast work; it may be used with judgment for medium or slow work. Maize, however, is not so safe a food nor so well balanced as the oat, although when the price of both foods is moderate, there is a wide difference in the cost of the feeding matter supplied. Let us suppose that maize costs 25s. per quarter of 480 lb., and oats 20s. per quarter of 320 lb.—this weight providing a good sample. According to the following figures, 100 lb. of maize will provide 73·8 lb. of digestible dry matter, while 100 lb. of oats would provide only 57 lb.; the cost of the former would be 5s. 2½d., and of the latter, 6s. 3d., or, in other words, the nutritious matter of the maize would cost ·85d. per lb., and of the oats, 1·3d. per lb. [See table.]

Food.	Bushel. lb.	Price.	Digestible and Nutritious. Albuminoids.	Carbohydrates.	Fat.	Digestible. lb. per cent.	Cost of 100 lb.	Cost per lb. Digestible. Pence.
Maize ..	60	3/1½	8·4	60·6	4·8	= 73·8	5/2½	0·85
Oats (good)..	40	2/6	9·0	43·3	4·7	= 57·0	6/3	1·3

The third table is a suggested ration, to include maize, for a horse weighing 1,000 lb. in moderate work, the figures being approximate. With the same weight of maize and hay the oats might be replaced with 5 lb. of barley or 6 lb. of bran, or 6 lb. of desiccated grains; but a change should be gradual, the complete alternative never being immediately effected. Horses fed on such a ration should, when subjected to severe work, receive an increase in the quantity of oats, in addition to 2 lb. of beans daily. In all cases the horses of the farm benefit by an occasional warm bran mash, which it is customary to supply on the Saturday night, or an occasional handful of linseed meal, or of crushed linseed cake, the albuminoid ratio being maintained at about 1-5. The meaning of this ratio it is now necessary to explain.

Food.	Dry Organic.	Albuminoids.	Carbohydrates.	Fat.
12 lb. Hay ..	9·7	·70	5·15	·15
6 lb. Oats ..	5·0	·53	2·50	·25
5 lb. Maize ..	4·2	·42	2·90	·25
2 lb. Straw-chaff	1·6	·02	—	·70
	20·5	1·67	10·55	1·35 = 13·57

Albuminoid Ratio. This term means the proportion between the albuminoid and the non-albuminoid digestible matter of food. Nitrogen is a leading element in all albuminoids; it is not present in either fats or carbohydrates. Were we, however, to describe the two sets of constituents as nitrogenous and non-nitrogenous, we might mislead, inasmuch as a portion only of the nitrogenous constituents of food are utilised in the animal economy.

The Purchase of Horses. In buying a horse an expert may be deceived. The amateur is, therefore, advised to employ professional help, and thus to minimise his risk. Those accustomed to horses, however they may trust their own judgment in other respects, will do well to employ a veterinarian to examine a proposed purchase for health and soundness. A horse should first be seen at home in the

stable, and overhauled in every particular. The object should be to ascertain if there is vice, unsoundness in body or limb, and that the age given is correct, as shown by the teeth. Whether led at the walk or the trot, driven or ridden, it is well that a disinterested and capable groom or coachman should be employed unless the purchaser can trust himself. For his first examination the animal should be led to a level spot, where his teeth, eyes, wind, hearing, mane, withers, and limbs may be examined in turn. Something may be learned from the way he stands; hence he should be looked over from both front and back. He should stand firmly and four-square, not resting a weak limb or tender foot. He should be walked and trotted, ridden or in harness, and in the case of a draught horse, be placed in a loaded cart, which he should be required to draw and to back. Again, he should be tested for shying, kicking, and even bolting, as well as for any other vices which may be suspected. A sound horse should be able to see and hear clearly, and be afraid of nothing he sees or hears, including the motor-car. On return to the stable, he should not exhibit timidity, or temper, or weakness of wind or limb either immediately or after a lapse of an hour. For such troubles or diseases as spavin, ringbone, splints, sandcrack, navicular, fistula, pollevil, and the like, as already suggested, an expert should be employed. In selling a horse a warranty should never be given, either verbally or in writing, if there is a shadow of doubt on any point, for it includes faults of which the owner knows nothing. On the other hand, a buyer should endeavour to obtain a warranty for self-protection.

Horses for the Farm. The farm horse, being required for heavy draught work, as ploughing and rolling, drawing loads of manure to the fields and corn to the station or the merchant, requires great strength and endurance, as well as speed in walking. The object in breeding, therefore, is to obtain these qualifications. He must be of large size, well formed, the muscles being prominent where they are most needed, and the legs and feet absolutely sound and strong. Constitution demands plenty of room in the thorax—a prominent chest, which is deep and broad, and long, well-arched ribs, providing plenty of room for play of the heart and lungs. Add to these points docility and good temper, and we shall not be far wrong

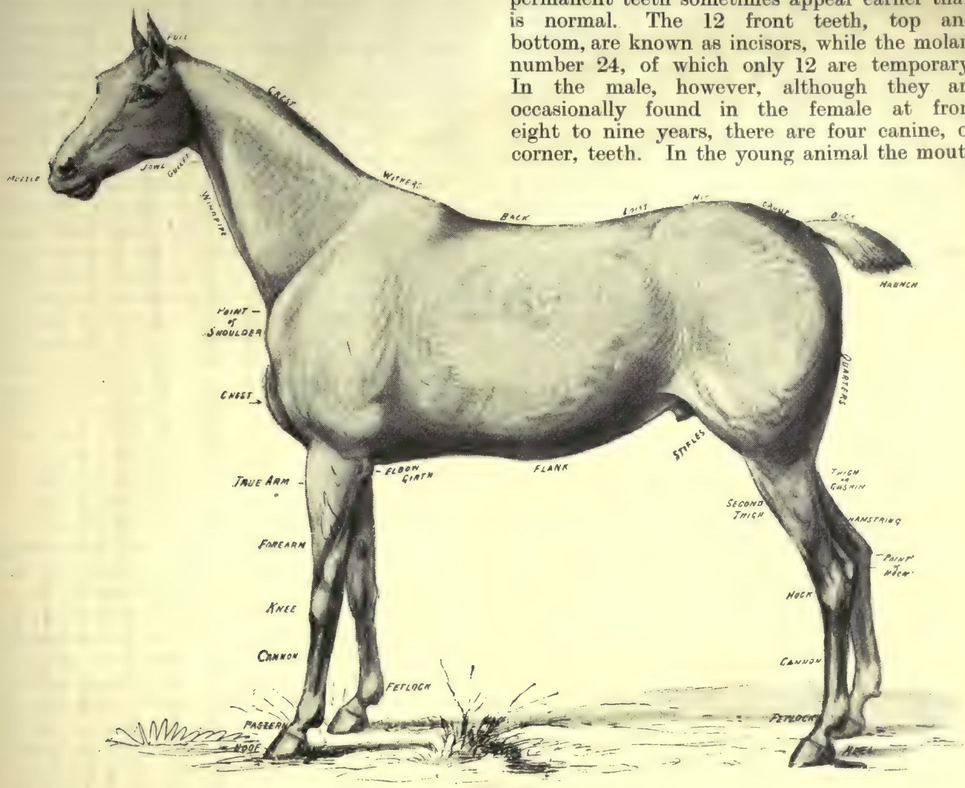
In selecting stock for breeding, it is important that the stallion, or sire, should have a long, straight head and broad forehead; short, wide, muscular loins; prominent, well-curved ribs; a belly proportionate to the size of the animal; fore legs which are straight, squarely set when looked at from the front, and not too far under the chest. The hind legs should be equally square, well formed, straight, without tendency either to bowness or what is termed "cowhock." The feet should be well formed, sound, neither turned inwards nor outwards, and always firmly planted on the ground. There should be neither defect of either eye or ear, still less of breathing. In a word it is imperative that for reproductive purposes both sire and dam should be in perfect health and vigour, and as nearly perfect in form and temper as possible. Farmers, however, are compelled to do the best with the means at their command.

The Mare. In many cases, mares are kept for field work and used for breeding purposes. The plan is a good one, but under no circumstances should a weedy, unsound animal be employed as a dam, however good the sire, for the practice means vexation, disappointment, and loss. If a mare has a pedigree, which in large part means reliability of constitution, so much the better. She should be in good condition, and without any serious fault, and the younger the better, although in many cases mares are employed for breeding up to an advanced age. Both sire and dam should be in the full vigour of life. The mare comes into season from seven to ten days after foaling. The breeding mare may be worked nearly to the date of foaling, but she should obtain a rest of a few days under any circumstances. Parturition occurs about 11 months after service, the date of which should be kept, and as the time closely approaches, it will be noticed that the udder commences to expand. The mare usually foals without assistance, whether on the pastures in sufficiently mild weather, or in the loose-box, where she should be subsequently kept for a few days prior to turning out with her offspring on a fine warm day in a paddock. After foaling she should receive a few bran mashes and an occasional mash of boiled roots, with crushed oats and sweet hay. The box should be specially cleaned, purified, and littered with clean straw before foaling. Should green food be available, it should be gradually introduced, unless the animal has been receiving green rations beforehand. Until mare and foal have been hardened off to outside exposure, they should return to the loose-box at night; subsequently both will benefit by remaining altogether upon a dry, yet soft, turfed pasture, on which they may be fed from a movable crib or manger from day to day. The mare should be kept in condition as well for the benefit of the foal as for her early return to work, while the foal should be liberally fed from weaning onwards. Without good feeding, size is unattainable, especially on poor soil. In the rearing of young horses, it is important that the best grass should be placed at their disposal, but it should neither be short nor wet, many foals being lost upon both, and on many parasites abound.

Weaning Foals. When the mare returns to work, the hours during which she should be employed should be gradually increased, but she should never work too long in the day before weaning, nor return to her foal while still warm, both practices being liable to cause diarrhœa, or scour, in the youngster. A strong foal may be weaned at the age of six months. If he feeds well, his ration of oats may then be increased, but the food supplied should always be of the best. Extra care should be taken with young stock in winter, and yet there should be no coddling. Colts may be turned in a well sheltered, or covered yard, where they can lie dry, and where they are protected against biting winds and driving rains. The

colt may be submitted to castration at from 12 to 15 months, the modern system being adopted.

Breaking. Farm colts and fillies are more easily broken than those of almost any other class. The breeder should make a practice of making friends with his young stock from birth. They may be handled, or even fondled, daily, as far as possible. Under such circumstances, breaking becomes extremely easy, and almost without any extra effort a young animal submits to the halter and subsequently to harness for the plough or the waggon. There should be no suspicion of harshness or cruelty in word or deed.



THE PARTS OF A HORSE

When, by the gradual introduction of the halter, the bridle, plough chains, and other harness, the young animal is submissive, he may be placed in harness by the side of a steady old horse, and induced to assist in drawing a log of wood, then a bush harrow, made on the framework of a hurdle or an old gate. This will prepare the way for attachment to a chain harrow, and subsequently to the plough, the roller, the waggon, and the cart. At first, the experiment may be a short one, gradually increasing until the colt becomes fit for a short day's work. He should be encouraged by word and act, and rewarded on his return to the stable, learning to recognise that he has given satisfaction. In this way a colt may be gradually brought into the daily work of the farm at the age of two and a half years.

The Age of the Horse. The adult male possesses 40 teeth, and the female 36, the temporary teeth in each sex numbering 24. These teeth are succeeded by the permanent teeth, which commence to appear at from two to two and a quarter years from birth. Where horses mature early, and where they are accustomed to eat coarser food than usual, the permanent teeth sometimes appear earlier than is normal. The 12 front teeth, top and bottom, are known as incisors, while the molars number 24, of which only 12 are temporary. In the male, however, although they are occasionally found in the female at from eight to nine years, there are four canine, or corner, teeth. In the young animal the mouth is complete with the temporary teeth at two years, and with the permanent teeth at five years old. The corner teeth at this age—those next to the middles—are but shells, while the middle and central teeth are well developed. When a horse has reached eight years and is aged, the marks on his teeth have been worn away, and it is next to impossible to mistake him for an animal of younger years. The trained expert is able to fix the age of a horse for some years afterwards, but this is scarcely a study for any but the dealer or veterinary surgeon.

Continued

THE REALITY OF THE ATOM

The Root Question of Chemistry. Physical Chemistry. The Atomic Theory is not Destroyed. Analysis of the Atom

By Dr. C. W. SALEEBY

OUR study of radium has prepared us in some measure to consider anew a question which is of far greater importance than any fact about radium as such, but a question to which the study of radium is gradually providing an answer. It may be said, perhaps, that the root question of chemistry is the nature of matter. That is also a question for the physicist, though not his root question. The physicist is, at least, as much concerned with the impalpable something we call *energy* as with matter; while the chemist concerns himself with energy only in so far as he needs to do so in order to understand the changes which matter undergoes—changes which, for convenience, we usually distinguish as chemical.

All Things are One. But it is now far too late in the day to speak or think as if there were any fundamental line of demarcation between Physics and Chemistry. Even ten years ago there was some little excuse, perhaps, for assuming that they were two distinct sciences, though this was not a notion which could ever be held by any would-be philosophical, still less by any distinguished student of either.

Nowadays, a man may call himself a chemist or a physicist, but he will be of exceedingly small importance as either unless he be both. Endless instances might be accumulated that serve to show how closely the sister sciences are interconnected. It is probably safe for the present writer to assume that there is no reader of this course who is not also a reader of the course on Physics. We may make distinctions, for convenience, between them, but ultimately the two sciences are one. Serious thinkers have always recognised—perhaps more as an article of faith than as an article of demonstration—that the distinctions between the sciences are, in the last resort, *man-made*. At bottom, the universe is a universe indeed, not a multiverse. "It is a flawless unit of fact," as a great American thinker has said, and when we isolate from it any particular aspect and proceed to study that, we must remember that we have performed an artificial process, the necessity for which is imposed upon us by the limitations of our minds, but which we must not permit to become a snare after being an aid.

Unity of Chemistry and Physics. There is no correspondence in nature—no fundamental correspondence, that is to say—to the distinctions between the sciences. Properly speaking, there are no sciences, but only science. The student might as well attempt to understand the anatomy of man without physiology, or the physiology of man without anatomy, as to study physics or chemistry independently. This is one of the reasons why we have, as frequently as possible, inserted cross-references between the courses upon these two subjects, and why one and the same topic has not infrequently been dealt with in both—now from the more distinctively chemical, now from the more distinctively physical point of view. But, indeed, the more the sciences advance the more they come to depend upon one another, and so the man who would be master of any one science must have some knowledge of all—the more the better.

Now, what has been the tendency in the case of the two sciences under discussion? Do they still stand on a level? Are they sisters? to repeat the common term. The answer most emphatically is that they are not. One has gained supremacy over the other. Nay, more—it has actually been able to include the other as one of its own subdivisions. The reader will not need telling which has become the dominant science. Were he in such need, we might again quote the profound saying of Bacon, who, centuries before the truth of his words were verified, declared that natural philosophy—a term practically equivalent to physics, which is, of course, derived from the Greek word for nature—is the "great mother of the sciences."

The New Science of Physical Chemistry. Modern chemistry must acknowledge its filial relation to modern physics. If not to-day, then to-morrow, or the day after, all the phenomena of chemistry must be not merely included amongst the phenomena of physics, but must be explained in physical language and regarded as physical phenomena, differing in kind not one whit from the phenomena which men have long recognised as coming under the heading of physics.

From one point of view, we may say there has been born a new science—*physical chemistry,* and this term does afford convenient means of indicating a certain series of inquiries; but all chemistry is really physical chemistry, and is more clearly seen to be physical chemistry the more nearly it approaches perfection. Thus, this question of the ultimate nature of matter is equally and alike a physical and a chemical question. Here we must attempt to discuss it more especially, of course, from the chemical point of view, asking questions which are especially suggested by chemistry—questions as to so-called chemical energy, as to valency, as to the nature of forces which determine the combination of elements for the formation of compounds, as to the decomposition of compounds, and, in short, all those interrelations of matter which are commonly distinguished as chemical.

The Limit of the Older Chemistry. And, in the first place, we must decide how far the older chemistry takes us, and the answer, of course, is that the older chemistry takes us as far as the atom. The standard chemistry is, indeed, based in the main upon the theory of atoms. On the other hand, students of this and its companion course have already found reason to see that the atom is not an ultimate ; and here we must insist upon an extremely important truth which is in very grave danger of being neglected at the present time. The casual reader is extremely apt to be misled, and, unfortunately, the casual writer as well. So soon as the physicists rudely disturbed the equanimity of the chemist by resolving the atom into smaller particles, people arose who said that, for instance, " the whole structure of modern chemistry has been swept away at a blow." That is, indeed, a nice comprehensive statement. For just a century chemists have been accumulating facts in thousands and tens of thousands which seemed capable of explanation on the atomic theory, and on that alone. Our notions of molecules, and of molecular constitution, our conceptions as to what constitutes a compound, and differentiates it from a mixture, our positive and experimental knowledge—not theoretical knowledge, be it observed—of the laws of valency and of atomic heat, the law of Avogadro, and many more—all these, forsooth, are to be swept away at a blow because the old conception of the atom can no longer stand. On page 1596 we spent half a dozen lines in protest against this view, as was indeed necessary before we could discuss the laws of compounds. But let us consider the matter, since otherwise we are not likely to go far in our search for an answer to the root question of chemistry.

A Grave Error. A still more recent writer than the one whom we have already quoted makes very short work of the atomic theory, and this in the course of praise showered upon Professor J. J. Thomson—whom the following sentence would scarcely gratify : " The atomic theory, which we were taught at school to regard as the foundation of chemical science, has been ' scrapped ' on the dust-heap of antiquated hypotheses." The present writer finds that this notion is to be found not merely among amateur commentators but even among competent students of sciences other than chemistry. The case is plausible enough. An atom is, by the derivation of the word, a thing which cannot be cut. It is an ultimate, an everlasting " foundation-stone," as Clerk-Maxwell thought, as Dalton himself thought, and well-nigh three generations of chemists after him. This assertion concerning the atom would appear to be the most essential assertion that can be made of it. Whatever else may or may not be true of the atom, at least it is a chemical ultimate as distinguished from a physical ultimate. However closely you examine iron you can never get any further than an atom of iron ; similarly with sulphur, while the difference between the atom of iron and the atom of sulphur is radical and eternal.

Upon the theory of atoms there has indeed been erected the imposing and seemingly stable structure of modern chemistry. Our scribe is correct when he says that " we were taught at school to regard the atomic theory as the foundation of chemical science."

Complexity of the Atom. But now there comes the physicist, who tells us that an atom is not an ultimate but is a complex body, consisting, at the very least, of a thousand smaller particles, which bear some such relation of size to it as a full stop bears to St. Paul's Cathedral. The hasty observer has, indeed, some ground for thinking that the foundation has been swept away, to the utter ruin of the superstructure ; and unquestionably this view would be not merely plausible but also correct, *if the essential part of the conception of the atom were its indivisibleness.* Now, it is this part of the conception which is usually regarded as essential. The present writer was taught that this is the essential of the atom. The textbooks regard it as such ; the less philosophic chemists, generally, have regarded it as such ; and the very meaning of the name goes to confirm this view. Nevertheless, we maintain and propose to prove that, during all this time, the emphasis has been laid upon a part of the conception of the atom which is not essential, which is of no importance whatever for the atomic theory, and which, to boot, is demonstratively false. To the latter assertion every one must now agree, but the two former will surprise all, save those very few who have attempted to understand the logic of scientific thinking.

John Stuart Mill's Anticipation. The explanation of the whole matter is to be found in a really remarkable paragraph occurring in Mill's " System of Logic," which dates from as long ago as the year 1843, the year before the death of Dalton. There are few passages in the writings of this great philosopher which more strikingly demonstrate the measure of his genius than this, or more signally show how the greatest minds, seeing all round a subject, are able to correct the narrow views taken by men who may quite well be distinguished workers in this or that field—chemistry, biology, or what not. In the introduction to his great work, Mill attempts to define logic and estimate its province. He declares that he must " attempt a correct analysis of the intellectual process called reasoning or inference," and then he goes on to say :

" With respect to the first part of this undertaking, I do not attempt to decompose the mental operations in question into their ultimate elements. It is enough if the analysis, as far as it goes, is correct, and if it goes far enough for the practical purposes of logic considered as an art. The separation of a complicated phenomenon into its component parts is not like a connected and interdependent chain of proofs. If one link of an argument breaks, the whole drops to the ground ; but one step towards an analysis holds good, and has an independent value though we should never be able to make a second. The results of analytical

chemistry are not the less valuable, though it should be discovered that all which we now call simple substances are really compounds. All other things are, at any rate, compounded of those elements: whether the elements themselves admit of decomposition is an important inquiry, but does not affect the certainty of the science up to that point."

How the Atomic Theory is Affected. Mill's argument is that it does not matter whether the atoms of the elements may be shown themselves to admit of decomposition, since, however important that question may be, the answer to it has no bearing upon the conclusions to which the atomic theory has already led us. The notion that the atom is indivisible does not constitute a link in the chain of argument which we call the atomic theory. Mill admits that if it did so the whole theory would drop to the ground. To-day many people think that the alleged indivisibility of the atom is an essential part of our conception of the atom, and is, therefore, a link in the argument. They know that the link—if it were a link—is broken, and they conclude, by correct logic from a wrong premise, that the whole structure of modern chemistry has been swept away at a blow.

But observe how remarkable is the applicability of Mill's illustration to our present difficulty. We have gone far to prove, and, beyond a doubt, will shortly go all the way to prove, that "all which we now call simple substances (elements) are really compounds." But this does not matter. Neither chemist nor physicist doubts that, as Mill said, "all other bodies except those so-called elements are at any rate compounded of those elements." This fact remains a fact, as is the nature of facts, and is affected in no degree at all by the modern discovery of the decomposition of the elements.

What then must we give up? Certainly, we must abandon what may perhaps be called, in order to distinguish it, the "atomic theory of the atom," the theory that the atom is literally atomic or indivisible. Indeed, it has been suggested that the term atom must be transferred to the corpuscles, or electrons, of which atoms are now known to be composed—corpuscles which seem to be, indeed, atomic or indivisible. But it would be a great mistake to transfer the name in this fashion, even though on the score of its derivation it is quite inapplicable to what we now call atoms. The name may remain, and will serve the students of countless generations as a convenient text for the illumination of one most important phase in the history of thought.

Atoms are Realities. But whether or not we give up the name, certainly there is no chance of our giving up the conception. No one again, indeed, will ever liken atoms to foundation-stones, or declare that they bear upon them the "stamp of the manufactured article." Such phrases cannot be permitted in the light of the conclusive evidence which we now possess of the evolution of atoms, the heavier and more complex having been demonstrated in several instances to break down into the lighter and simpler. But, as the present writer has said elsewhere—and the illustration is perhaps significant—"we no more question the existence of atoms because we are beginning to understand their structure and the nature of the actual elements of which they are composed than we question the existence of animal organisms because we know they are all composed of cells; of cells because we know they are all composed of molecules; or of molecules because we know they are all composed of atoms." Mill's remark was that one step towards an analysis holds good, and has an independent value though we should never be able to make a second. Well, chemists have made several steps towards an analysis, and these do not hold the less good simply because the physicists have taken a further step yet. But, indeed, for the steps taken by chemistry physics could not have gone further.

The Theory is Really Strengthened. But this is not all. So far are these new discoveries from having swept away at a blow the whole structure of modern chemistry, that they have actually afforded signal support to this great structure, which stands far more securely with their assistance than it previously did. Let us take an instance. The reader is familiar with the periodic law—to which we have already been compelled to pay an amount of attention which would have seemed ridiculous ten years ago. The law asserts, the reader will remember, that if the elements are arranged in the order of their atomic weight, certain groups of characters are found regularly to recur, so that the characters of an element are a periodic function of its atomic weight. This law has vindicated itself by leading its propounder, Mendeleef, to predict the discovery of elements which have now, indeed, been discovered, and which actually have the characters that he assigned to them, just as the law of gravitation vindicated itself by leading to the discovery of Neptune. We may also remind the reader that the group of rare gases found in the air have astonishingly fitted into the periodic table. But upon what is the periodic law based?

Value of the New Conception. Most evidently the periodic law is based upon the conception of atomic weight, and this, of course, upon the atomic theory; and this, forsooth, far more certain to-day than ever it was, is declared to have been "swept away at a blow." But we have declared that the law will furnish an illustration of the view that the new conception of the atom makes still more secure the structure of modern chemistry, and the fact to note is that it is the new theory of matter, the theory which implies the disintegration of the atom, that alone affords an explanation of the manner in which the elements are related to one another, the manner in which the atoms of various elements display a tendency to unite with one or more atoms of other elements, and the manner in which the properties of elements seem to recur as one passes onwards from those of less to those of greater atomic weight. There is no essential

part of the atomic theory which has done anything but gain in consequence of recent work. The notion that in the atom we have the ultimate result of analysis has never satisfied philosophers —as our quotation from Mill suggests—and, although on a superficial view this notion may appear to be the essential part of the atomic theory, it is really not essential at all. To quote another illustration from astronomy, we may say that Kepler's theories of planetary motion were not in the smallest degree affected because his great successor Newton was able to refer the ultimate cause of that motion to gravitation, whereas Kepler still retained the ancient notion that the movements of the planets were directed by spiritual beings whose abode they were.

The "Life" of Atoms. We have then to conceive of matter, in all its common forms at any rate, as being reducible—not ultimately, but still at a certain stage in analysis—to bodies which we still call atoms. These atoms themselves may be immeasurably complex, but they are no more without individual existence of their own on this account than St. Paul's Cathedral is without an individual existence because it is made of stones, or than the body of an animal is without an individual existence because it is made of cells. For the *ordinary* purposes of chemistry these atoms may indeed be regarded as ultimates, and they are a surer, because a truer, foundation for chemical science than they were when we had no better conception of them than Dalton's or Clerk-Maxwell's. But since they are not ultimates, they are subject to the common fate of everything else that is not an ultimate—they are subject to birth, development, disintegration, and decay. The chemist studies them mainly in what we may call their adult stage. Their lives are extremely long in the great majority of cases, and thus there are immense periods during which, for the purposes of the chemist, at any rate, they may be regarded as permanent. The law of the conservation, or indestructibility, of matter—that is to say, of atoms—cannot stand rigorous criticism, dictated by recent knowledge. But the periods of stability are so prolonged in the case of all but a very few atoms that the chemist is able to proceed as if the law of the conservation of matter were really true.

The Change in 12,000,000 Years. In the course of ordinary chemical decompositions and the like, atoms do not disappear ; chemical equations such as those of which we have seen many examples are not fictions, but correspond to truths ; and when it is demanded of a chemical equation that the same number of atoms and the same number of each kind must always be represented on both sides of the equation, or else it is no equation and falsely represents the chemical facts, we are making no unreasonable or imaginary demand, but one which is imposed upon us by the facts. In the course of ordinary chemical actions atoms do not disappear, nor, on the other hand, do they come into being. The physicists tell us, and provide abundant proof of the assertion, that these atoms of which we write as if they were so many permanent bricks are really undergoing slow change—that in 1,200 years atoms of one kind will have changed into atoms of another, or that in 12,000,000 years atoms of a third kind will have changed into atoms of a fourth. Meanwhile, we, whose observations are confined to minutes or days or a few years, are at liberty to assume, for practical purposes, that the stable period of atoms, except in the case of the very heavy ones, is permanent.

Man and the Atom. And here we are in a position to make an important distinction. Just as in the case of a member of a society, we may raise two inquiries concerning an atom, a man may be considered from two points of view. We may ask concerning his internal processes, as to what he thinks in his heart of hearts, as to how his mind develops and changes and reaches, perhaps, a changeless period, as most minds do in later life ; and, on the other hand, we may consider the man in his relation to other men. On the one hand, we consider him simply as an individual, on the other as a member of a greater whole ; but while we observe this distinction we must remember the principles laid down in the beginning of this article, and realise that at bottom the distinction is an arbitrary one. A man's life is not made up of two independent sets of processes—one individual and the other social. On the contrary, these are incessantly reacting upon one another.

Now let us see how this analogy helps us. In the case of atoms, we thought until the other day that there was only one set of processes to consider—the social processes, so to speak. Chemistry accepted atoms as changeless and permanent, and its business was, and, indeed, still is, to ascertain the way in which atoms behave in relation to one another. If we could ascertain this in its entirety, we should have, it seemed, a perfect chemistry. There did not seem to be the slightest reason to suppose that there were any other processes than these. But now we know better. Physicists have taught us, not, as incompetent commentators aver, that atoms are a "baseless fiction," but that atoms have their individual processes as well as their social processes. It is with the latter that chemistry, as it used to be conceived at any rate, is concerned. It is the former, the existence of which was until lately unsuspected, that is now exciting the interest of all students of science. We may use two convenient terms to express the difference.

Social and Individual Processes. The material processes which we have to study may be described as belonging to two groups—the inter-atomic and the intra-atomic (from Latin *inter*, between, and *intra*, within). But this analogy between the human and atomic organism—for which the present writer must take the responsibility—is even more complete and, we think, valuable than has yet been indicated. For we have said that it is impossible in point of fact to consider the social and individual lives of men as if they were independent. On the contrary, the truly wise student of society

knows that the key to social phenomena is human nature. What does this mean ? Plainly, that the social processes can never be really understood so long as we assume either that they are all the processes to consider, or that the individual processes have no relation to them. In order to understand the relations of human beings—their unions and disunions, attractions and repulsions, marriages and divorces, combinations and separations—it is absolutely necessary to study the characters of individual men, which determine all these processes, and these characters can be understood only if we study the internal individual processes of men. *As a man thinks so is he.*

The Atom Vindicated. And it is so with the atom. The facts are directly opposed to the statements of those who say that the discovery of the intra-atomic processes has swept away the structure of modern chemistry, which is concerned with the inter-atomic processes. It is as if men had been thought to have no internal conscious life, and society had been studied on this assumption ; but one day it was realised that men had their own internal processes of thought and feeling, upon which commentators asserted that all that was hitherto known concerning the social relations of men was false. On the contrary, the new discovery would explain and immeasurably amplify such knowledge. No commentator would say anything so silly as that men had no real existence because they were discovered to undergo internal change ; though a parallel assertion has been made of the atom.

The discovery of the intra-atomic forces and processes is already illuminating, and will more and more continue to illuminate and amplify our knowledge of the inter-atomic processes ; just as, in the state of affairs we have imagined, the study of individual psychology would amazingly explain and add to our knowledge of the facts of sociology. Furthermore, our knowledge of the intra-atomic processes is leading us to our first real comprehension of the already known characters of atoms and their behaviour. King Solomon, the wisest man of antiquity, has declared of man "For as he thinketh in his heart so is he" (Prov. xxiii. 7). And the modern chemist is just coming to realise —as we shall see ere long—that the internal processes of the atom determine its character, and thus its relations to other atoms—that is to say, its inter-atomic processes, its chemical behaviour. Was anything more ludicrous ever said than that these new discoveries have caused the atomic theory to be "scrapped on the dust heap of antiquated hypotheses" ?

Analysis of the Atom. We have deliberately discussed this subject at great length, since it is absolutely necessary to do what may be possible in order to counteract a misconception which is extremely widespread, which is rapidly gaining ground among the uninitiated, and which, unfortunately, strikes at the very root of any real understanding of chemistry. Atoms unquestionably exist, and constitute the ultimates of the elements as we know them.

Now, it may not unreasonably be argued, one would think, that the business of the chemist stops at this point; that directly we begin to analyse the atom, to concern ourselves with the intra-atomic processes, we are wandering from our subject, which is, properly speaking, the social aspect of atomic life; we are committing the fault of the sociologist who begins to study individual psychology. But these barriers and distinctions and delimitations are relics of an outworn order of thought, or, to change the metaphor, they are like temporary scaffolding arrangements which can be removed as the building approaches completion. If it be true that the key to sociology is to be found in human nature, the sociologist is right in studying individual psychology.

The Chemical Processes. Similarly, if it be true that the key to chemical processes is to be found in the internal individual processes of atoms, the chemist is right in considering them. They are the key to everything that interests him, and even if his means of study have to be modified, even if he can dispense with nearly all his test-tubes, even if he require to leave his own laboratory and enter the laboratory of the physicist, and be told that he has forsaken his first love, he must "see this thing through." He cannot be arrested at the edge of the atom. On these grounds and on those other grounds which we began by stating, we offer no apology for proceeding to study this subject in this course instead of the course on Physics. In any case we have failed in our task if the interdependence of the two courses has not been made manifest.

Continued

ELECTRIC RAILWAYS

Types of Railway Service. Comparison between Steam and Electric Locomotives. Methods of Electric Propulsion. Collection of Current

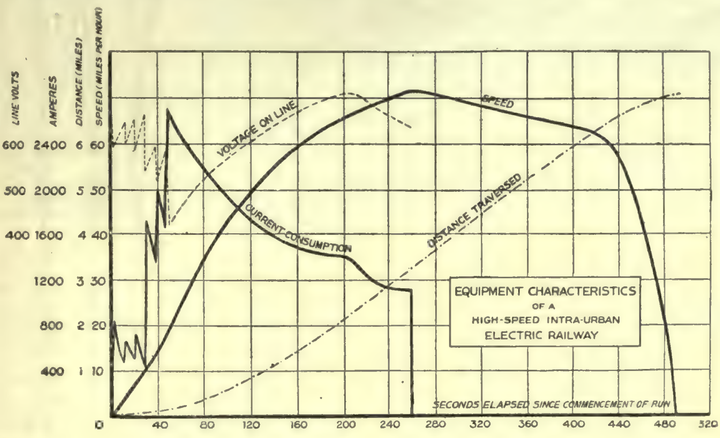
Group 10
ELECTRICITY
15

Continued from page 1936

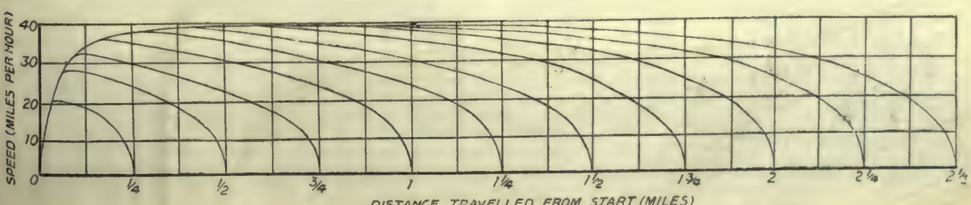
By Professor SILVANUS P. THOMPSON

WE shall begin our discussion of the electric railway by a short consideration of the typical classes of railway service necessary for present-day requirements. Modern train services may be roughly classified under two headings—namely, (*a*) main line services, in which the stations are some miles apart, and (*b*) suburban services, in which the stops are very frequent, often as many as three or four to the mile. The former of these types of service has yet to be electrically developed, but the greater part of the latter has now passed out of the domain of the steam locomotive.

All travel must nowadays be expeditious. To attain a high-speed main-line service one requires only to arrange for a high maximum speed without much regard to starting and stopping. For suburban service, however, attention to these last is all-important, for whereas in the previous case the train is running for most of the time at its top speed, in this case the maximum speed can be kept up only for short periods, for a large part of the time between stations is taken in speeding up or accelerating the train after a stop and in slowing down or retarding it for the next stop. It is obvious that time, under these conditions, can be saved only by getting up to a maximum speed as quickly as possible, and by bringing the train to rest as quickly as possible. These questions of acceleration and retardation become more and more important as we deal with systems in which the stations are nearer and nearer together. To illustrate this point from actual practice, an experiment, from which the curves in **148** have been plotted, was carried out a few years ago, and a steam train made a series of journeys of varying lengths over a level piece of track and observations were made of the time taken. The train was first taken a quarter of a mile from a station and the driver was instructed to run to and stop at the station as in actual service, and the times and speeds were noted. The train was then taken half a mile away and was run into the station as before, and the experiments were continued in this way until the run was for 2½ miles. In **148**, distances from the start of each run are plotted horizontally and speeds in miles per hour are plotted vertically. We learn from the curves that this train with the type of engine used had a maximum speed just under 40 miles per hour, and that it required to travel half a mile before this speed was attained. In consequence of this, and also of the time spent in braking, the average speed was much reduced, as shown by the final results worked out in the following table.



147. ELECTRIC RAILROAD CHARACTERISTICS



148. SPEED TESTS ON STEAM TRAIN FOR VARYING RUNS

149. ELECTRIC LOCOMOTIVE

Distance between stops (miles).	Maximum speed attained during run (miles per hour).	Average speed during run (miles per hour).
$\frac{1}{4}$	20	15·3
$\frac{1}{2}$	27·5	20·8
$\frac{3}{4}$	31·7	24·2
1	35	26·8
$1\frac{1}{4}$	37·2	28·6
$1\frac{1}{2}$	38·5	30·1
$1\frac{3}{4}$	39·5	31·3
2	39·5	32·3
$2\frac{1}{4}$	39·5	33·1
$2\frac{1}{2}$	39·5	33·7

Accelerating Power of Electric and Steam Locomotives. It will be seen from the above that for suburban work the locomotive, apart from any capabilities it may have of propelling a heavy train at a high speed, must be able to exert a very large effort at starting ; an effort which may be several times greater than that required at the maximum speed, much in the same way as a horse can exert at starting a pull which is several times greater than that required afterwards to keep the vehicle at top speed.

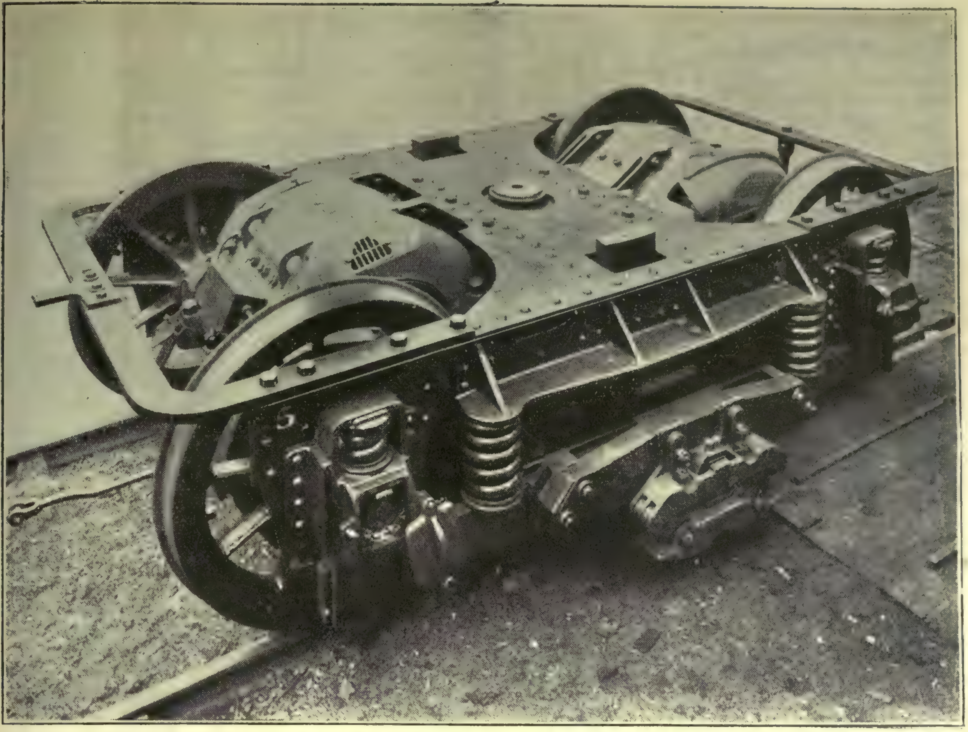
It is because the electric locomotive fulfils these conditions so admirably that it has been so extensively adopted for this class of work.

There are other advantages, among which are that the driving units can be split up conveniently to drive long or short trains at will, that in tunnels and tubes so much in vogue in suburban lines it produces no smoke or steam to contaminate the atmosphere, and that the method of generating the whole of the energy at one big central station is more economical both in the quantity of coal consumed and in the total labour charges over the system.

Railroad Characteristics. Just as we plotted a set of curves [**129**, page 1931] to show the characteristic properties of a series motor, so, in order to show the performance of a certain equipment on a certain railway, the railway engineer plots a set of curves such as is shown in **147**.

The various curves are plotted to a common time base, generally graduated in seconds, and the various curves represent (*a*) the current consumed from instant to instant, (*b*) the voltage on the motors, (*c*) the speed of the train during the run, and sometimes (*d*) the total distance traversed from the starting point. By reference to these curves we can see at a glance whether the equipment has been used in a proper manner or whether it is suitable for the work in hand. Let us consider the current curve. At the start it consists of a series of irregular peaks, showing how the current increases when successive resistances are cut out by the controller, and how it then decreases as the train acquires more speed. After the final running notch is reached the current then continuously decreases until, at a certain distance from the

150. MOTOR COACH ON LANCASHIRE AND YORKSHIRE RAILWAY



151. MOTOR TRUCK ON LANCASHIRE AND YORKSHIRE RAILWAY

end of the run, it is shut off altogether, and the train is allowed to coast for the rest of the journey until the brakes are applied as it enters the station.

Looking at the voltage curve, we see that every time the current rises the voltage goes down owing to the increased voltage drop in the rails and feeding cables. The speed curve is the most interesting of all, in that by its initial slope we gauge the quickness with which the train gets under way at starting and the quickness with which it is brought to rest. We can also state the proportion of the time during which it was running at full speed. In the curve this is about 180 seconds, or only 37 per cent. of the whole time taken on the run.

Methods of Adopting Electric Propulsion. In the first electric equipments which were put into service, the practice of using a separate locomotive, as in the steam lines, was adopted, but the considerations given below soon pointed to another method—namely, of distributing the units of propulsion—*i.e.*, the motors, in different carriages along the train, a system which for obvious reasons could not be adopted in steam locomotion.

In the first place the electric locomotive is much lighter than the steam locomotive. The Great Northern Railway has recently introduced on its suburban lines a new type of steam locomotive which is, perhaps, the most powerful yet made in this country for its purpose. Comparing the performance of this with the electric locomotives of the Central London Railway which, however, have now been discarded for a still better arrangement, we have :

Locomotive.	Weight.	Tractive effort.	Tractive effort per ton weight of locomotive.
Steam (G.N.R.)	70¼ tons	35,000 lb.	500 lb.
Electric (C.L.R.)	31 tons	20,000 lb.	650 lb.

It is to be further noted that with the steam locomotive the tractive effort rapidly falls, but that with electric propulsion the effort is continued throughout the period of acceleration.

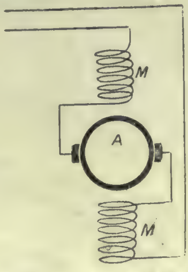
The decreased weight of locomotive, shown in the last column, is, of course, an advantage, for the extra weight is dead weight and carried to no useful purpose. The drawback, however, is that a certain weight on the wheels is necessary in order to obtain the grip on the rails for driving [see remarks on page 1934], and as the electric locomotive was lighter, the scope for further increasing its effort was limited. The result, then, was that the motors were divided into two or even three sets and were installed on the different coaches so that the weight of the coaches themselves might be used to give the necessary grip on the rails. Further,

the weighty locomotive has been entirely done away with and only the weight of the motors has been added to the train. The following figures from the practice on the Central London Railway illustrate this point.

Original Equipment. Locomotive and seven coaches. Total weight of train, 137½ tons. Seating capacity, 336.

Present Equipment. Two motor coaches and five trailing coaches. Total weight of train, 113½ tons. Seating capacity, 324.

The decrease in the weight of the train is 17·5 per cent. as against a diminished seating capacity of only 3·6 per cent. For special circumstances the electric locomotive is still used, and **149** shows one used on the Metropolitan Railway, London, for propelling coaches formerly used with steam locomotives.

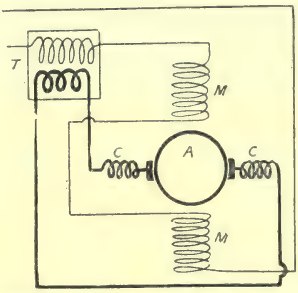


152. DIAGRAM OF SERIES MOTOR

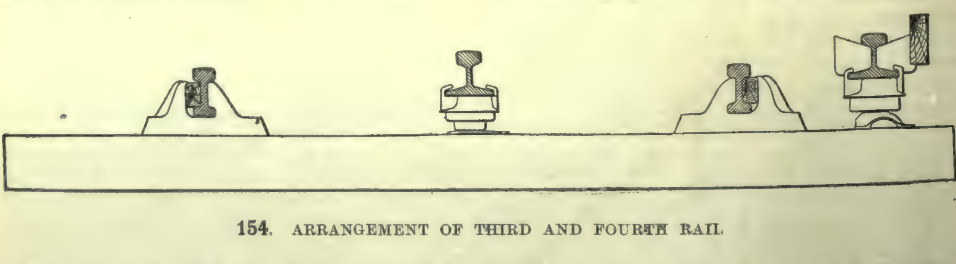
Fig. **150** shows one of the motor coaches used on the Lancashire and Yorkshire Railway. The usual arrangement as here adopted is to partition off the front part of the coach and there to install the controlling apparatus, although in some of the equipments for the London District Railway all the controlling gear is fitted underneath the car.

In the coach shown both the front and rear trucks are fitted with two motors each, but here again practice differs, for on the Central London line, only the front truck is so equipped. Fig. **151** shows one of the Lancashire and Yorkshire motor - equipped trucks and also the arrangement of the collecting shoe at the side.

Systems of Electrical Traction on Railways. At the present time the continuous current system at 500–750 volts is largely used, although other systems using single-phase, three-phase, or high-pressure continuous currents may, except the last, be said to be past the experimental stage and are in use to a limited extent.



153. DIAGRAM OF SERIES MOTOR, WITH COMPENSATING WINDING AND CURRENT TRANSFORMER



154. ARRANGEMENT OF THIRD AND FOURTH RAIL

The continuous current system is the series-parallel arrangement already described for tramways with such modifications as are required for dealing with the increased output of power and for the control of two or more motor-coaches from one platform. These will be described later.

The Single-phase System. It is not practical to transmit for more than a few miles large quantities of electric energy at ordinary voltages, and although it would be practical to *transmit* it, it would appear that commutation and other difficulties in the *generation* of high voltage continuous current have yet to be surmounted.

For transmission purposes, we therefore rely on high voltage alternating currents which have to be converted [see under Systems of Supply] into continuous current at low voltages for use on the railway track. In order to do away with this transformation, engineers have attempted to construct a single-phase motor [page 1595], the principle of whose action is the same as the continuous current series excited motor, but which can take alternating current straight from a high voltage transmission line. The motor is shown diagrammatically in **152**, and the connections are just the same as an ordinary tramway motor. [Compare **72**, page 1324.] Improvements are, however, effected by the use of the arrangement shown in **153**, in which (*a*) the current as it goes to the armature A is transformed up to a lower voltage, at T, and (*b*) an extra winding C, called a compensating winding, is introduced on the magnet system and is so placed that it does not necessarily produce any extra magnetism, but rather opposes the distorting action of the armature current. Both these improvements lead to better commutation. [See mention of auxiliary poles on page 1324, and consult **89**, page 1591.]

Action of the Single-phase Railway Motor. The reason why the same motor will act in the same way when supplied with both alternating and continuous current is easily seen from the rule of the right hand explained on page 1104, where, in **43**, we have the direction of the magnetic field given as towards the left. The voltage is applied and, therefore, the current flows towards us and we

155. THREE-PHASE LOCOMOTIVE AND TRAIN

see that the resulting motion is upwards. This represents the state of things for continuous current or for one half, say the positive part, of the alternating current wave [83 and 84, page 1362]. Now consider the case of the second half—*i.e.*, the negative part of the alternating current wave. The direction of the voltage and therefore of the flow of the current has altered and the magnetism in consequence has also altered in direction. Now place the right hand so that the first finger points to the right and the second finger points away from one, and you will see that the thumb, indicating the direction of motion, *still points upwards*, thus showing that in whichever direction the current flows through the machine, the direction of motion is the same, whether the current at the moment is flowing forward or backward. For further study, readers should apply the reason to the actual case of a field-magnet and a current-carrying conductor shown in **87**. It may be asked, if the direction of rotation is independent of the direction of application of the voltage, how then is the direction of rotation altered? This is done, as explained on page 1591, by reversing the connections of either the field magnets or the armature, and this process also should be thought out by the reader by the use of the right hand rule.

156. HIGH-VOLTAGE OVERHEAD RAILWAY LINE

It is obvious that as the construction and manner of working is the same, the characteristics, so suitable for suburban traction purposes, of the continuous current are also obtained in the alternating current series motor, and the remarks on page 1931 regarding the former apply to the latter.

Three-phase Traction. For long-distance traffic, the three-phase motor has been applied in Italy and other places. When once under way the speed of the train varies only within a few points per cent. whether the train is on an incline or a decline, and in this way a high scheduled speed is maintained all along the route. The maximum speed depends of course upon the frequency of supply and the number of poles on the motor, and these have to be

considered when the line is planned out. An advantage with the three-phase motor is that when running downhill it may be made to act as a generator ; but whereas in the series motor the electrical energy so produced must be absorbed in resistances, in this case it can be returned to the line, and so help in driving another train up the hill.

A disadvantage of the system is that three conductors are required ; these are usually arranged as shown in **155**, two as overhead wires, from which current is collected by means of bows, and the third the running rails, or else an insulated rail.

In places, such as at level crossings, where the insulated rails have to be discontinued, the two overhead lines can temporarily run the three-phase induction motors as single-phase induction motors, but the performance of the motors under these conditions is not satisfactory for any length of time.

The Collection of Current. In low voltage continuous current working, where currents at 600 volts are used at starting, the live conductor takes the form of a steel rail, which is laid on a level of the track, the current being collected by shoes or skates, as shown in **149**, **150**, and **151**. Previously only one extra rail was used, and the track rails carried the return current, but now a fourth rail is laid down the centre of the track, as in **154**, and in some systems is, like the third rail, insulated from earth. This figure shows the actual arrangement adopted on the London Metropolitan Railways, and is, but for the question of the insulation of the return, the arrangement mutually agreed upon by the railways of Great Britain.

The method of suspending the wire on railways which have adopted one of the high voltage alternating current systems is shown in **156**. The copper wire which from a current carrying point of view may be smaller than that used on tramways, is not directly supported from the poles by ears, etc., as shown on page 1936, but is suspended from a galvanised steel wire, which in its turn is supported from the posts. The advantages of this arrangement are as follows : (1) The copper trolley wire may be suspended without any sagging, by making the short suspending wires between it and the upper steel wire of different lengths ; (2) the poles may be erected further apart, because the strain of each span now comes upon a steel wire instead of upon a copper wire ; and (3) the use of the two wires gives a smaller resistance to current passing from the feeding point to the train, and so the feeding points may be fewer.

Multiple Unit Control. The principle of and the necessity for multiple unit control has already been stated. The control apparatus consists essentially of a small controller on the driver's platform by means of which small currents are sent to each motor-coach to actuate the larger gear installed there for the distribution of the heavy currents taken by the motors themselves. The master controller can be supplied with current from the line; but the Westinghouse Co. in their system supply a set of accumulators for only 14 volts to work the master controller circuit, it being claimed that otherwise no current is available to connect the motor switches into the braking position. As to the manner of operation of the large motor switches, this is done either by solenoids working through master controllers or by air pressure, the valves of the air pistons being worked by current from the master controller.

A further improvement has recently been introduced, and in this the rate of cutting out resistance [see page 1933] is beyond the control of the motorman. The master controller contains only one series and only one parallel notch, and having moved on to one of the notches, the closing of a switch for removing resistance is performed automatically by the motor controller as soon as the current falls to a certain prearranged value. In this way a uniform acceleration is obtained, and no waste of current takes place.

Continued

CYCLOPÆDIA OF SHOPKEEPING

CUTLERY AND TOOL DEALERS. The Prospects and Scope of the Trade. The Nature of the Stock. Prices and Terms of Credit. Profits

CYCLE DEALERS. Qualities Necessary in a Cycle Dealer. Buying and Selling. Repairing and Hiring. Accessories. Side Lines

CUTLERY AND TOOL DEALERS

The selling of cutlery and tools is a department of retail trading which is usually associated with the business of a general ironmonger. But in these days several branches of the complex trade of the ironmonger are becoming, more than formerly, specialised and dissociated from the parent tree upon which they have been wont to grow. No pruning from the ironmongery business is more likely to take independent root and become a healthy shrub than that of selling tools and cutlery. No apology is needed for considering tools and cutlery together. In the nature of the merchandise, the sources of supply, the terms of trading, and the manner of keeping stock, they are closely allied. The selling of cutlery alone would scarcely prove remunerative, although the selling of tools only might well be so; but the man who sets up business as a tool merchant would be foolish if he did not consider that cutlery also came within his proper sphere.

Personal Qualities. The retailer of tools and cutlery must have an intimate knowledge of the wares he offers. No class of customers is more difficult to please than that of artisans who have occasion to purchase the implements of their handicrafts. Details which seem to the unsophisticated spectator unimportant to the point of triviality are, to the workman, vital to good work and essential to his acceptance. This consideration is the main reason for the possibility of successful trading by the small man of the proper type in face of all the competition which capital and organisation can pit against him. The dealer who will listen to all the objections of the exacting purchaser, who will appreciate his point of view if he cannot accept all his criticisms as reasonable, and who can exhibit a practical acquaintance with the use of tools, is always preferred by the artisan tool buyer to the ironmonger's assistant whose knowledge of tools is not deeper than that gained by unpacking and pricing them. Thus, the smart workman, with business capacity, who ventures into the field of shopkeeping as a dealer in workman's tools need seldom fear the issue provided he select a district where workmen frequent the shopping thoroughfares, and if there are not too many of his own kind already exploiting the same trade.

Locality. The provincial village is not the place where such a venture may be attempted. Men do not eat tools, and there must be a large population upon which to draw for support. It is also obvious that an industrial and not an agricultural centre offers scope for tool selling. The choice of a shop need cause the prospective tool-seller less concern than other retailers who are in quest of business premises. The tool shop need not be pretentious, nor need it be in the fashionable thoroughfares where shops, even little larger in size than decent matchboxes, command ransom rents. Fortunes have been made, and will continue to be made, in modest quarters with low ceilings. Workmen, indeed, usually avoid the large, pretentious business palaces in favour of the small tool shop, whose proprietor wears the black apron himself, and discusses the merits of the latest combination plane with the carpenter customer. The place must be dry—dry as a bone. That is imperative; otherwise rust will play havoc with the finest stock of tools Sheffield can produce, entailing a world of attention to maintain it in saleable condition.

Stock. Tools are expensive stock. Much value may be put into very little space; but the dealer may buy most of it in quarter-dozen lots of an article, or even one-third of this quantity, and by displaying nearly all he holds, disguise the poverty of it. A little skill in the selection and arrangement of his shop fittings will enable him to do this successfully.

The tool merchant cannot set up his sign and make a good show unless he spends from £300 to £400 in stock. Even then he must buy small and often. One thing favours him. His trade will be entirely cash, unless he be very unwise, so that he need not have capital sunk in book debts. He thus suffers little loss through bad debts.

Many circumstances must guide him in the selection of his stock. He must judge what proportion of his trade is likely to be with amateurs or ordinary householders, and what proportion he may expect from workmen. Better goods can nearly always be sold to artisans. That is not to say that the profits are larger, but that the man whose business it is to handle a tool every working hour of the day demands quality before anything else, and knows that he must pay for quality. The amateur, on the other hand, unless he be the exception, considers a German saw at 3s. 6d. as good for his purpose as a good Hallamshire tool at double the price. And the German article may even carry the larger specific margin of profit.

Thus, there are two distinct classes of tools that must be kept—good tools for judges of good tools, and cheap tools for the buyers of cheap tools.

Carpenters' tools will form the most important part of the stock of almost any tool merchant. The carpenter must purchase his own tools, but

ironworkers, except in exceptional cases, have their tools provided by their employers. Thus the bulk of the trade in ironworking tools does not reach the user through the hands of the small merchant, but goes direct from the large city factor, or from the manufacturer himself.

Where to Buy. In most cases it is wise to seek direct relations with the Sheffield manufacturer. He may factor half the goods which he catalogues, but as good terms may be had from him as from the actual maker, who very often does not deal with the retailer at all. A fair proportion of the tools sold, even by Sheffield manufacturers, are foreign tools. It may be accepted as a generalism that American tools are nearly always good, and compare with the best English makes, sometimes showing decided superiority, but that German tools, except for the articles embraced in the class known as Lancashire tools, are suited only for the second-class trader. In tools, the name "American" is usually a recommendation, while an acknowledgment that the article is "made in Germany" is enough to make the wise man select something with a different parentage.

The proportion of German tools stocked will depend, therefore, upon the volume of second quality tools that are to be sold. The dealer had better place his initial order, even for German tools, with a Sheffield or Birmingham house, although, a little later, he will find it economical to open relations with the German manufacturer through his English representative, whose headquarters are usually in London. German goods of this class offer the factor the opportunity of rather large profits, and, naturally, the retail merchant wishes to avoid the employment of unnecessary intermediaries who enhance the price of the goods. He will, however, find it impossible to import direct from America. The British representation of American manufacturers is usually in the hands of one or other of the large British factoring houses, behind whose back the retailer can seldom get.

The Value of a Name. Brand counts for much in the tool trade, and local taste decides what brand is in favour in each particular district. In one district, for instance, it may be essential to the acceptance of a saw by the local carpenters that it bear the name of Sorby, while in other parts of the country the name of Sorby may count for naught, and the legend "Spear and Jackson" or "Disston" be insisted on. This local preference prevails through almost every department of the edge-tool trade, and the beginner must make himself familiar with local preferences if he would avoid the purchase of slow or unsaleable stock.

Profits. There is no uniformity of discount in the tool trade. Trade discounts from net prices may run from 15 to 80 per cent. At the lower rate of discount the particular article would be sold at more than list price, and in the latter case at something less than half list price. The usual discount from, say, flat bastard files is 60 to 65 per cent. off Sheffield list, and a common selling price is from 40 to 50 per cent. from the same list. The dealer, of course, will refrain from initiating the public into the practice of calculating prices by discount in this manner.

The Sheffield terms are usually 2½ per cent. cash discount at one month or journey account, although some firms allow 5 per cent. The larger discount should always be taken advantage of, when prompt payments will secure it.

Shop Fittings. Care in stock-keeping must be observed if the stock is to be maintained in good saleable condition, and the shop fittings should be designed with this object in view. Rust is the great enemy of the tool and cutlery merchant, and prevention of rust is better than its cure. Indeed, cure is impossible. Rust, once allowed to take hold of a stock of tools, cannot be expelled. In every case rust impairs the selling value, although not always the utility. A hammer or a plasterer's trowel is just as serviceable even if it be rusty, but edge tools become seriously injured by rust. All tools should be carefully kept from humidity. Even the papers in which they are wrapped should be greased or at least pepper dry.

Many trades are best prosecuted by making a limited window display. A few specimens may do better service than many. The trade in tools is not one of these. The window should be filled with exposed goods, but the window enclosure should always be air-tight. This precaution not only preserves the stock better, but it diminishes the frequency of window dressing—an important consideration when many small articles have to be handled.

In the matter of shop fittings, we in this country are far behind the tool retailers in the United States, where they have been improved to make the merchandise visible to the customer, ready to hand, and excellent in arrangement. A few of the best examples of American shop-fittings are described and illustrated in the article on Ironmongers in this course.

The principle of some of these fittings can be applied to every class of hand tools the merchant has to carry. A few tool shops in Great Britain have been fitted with such fixtures, but the number is much smaller than it ought to be.

Cutlery. The cutlery department is relatively more profitable than that of tools. It will form the smaller proportion of the stock value, and will not demand so much room for warehousing and display. Proportionally, cheap cutlery pays better than the better qualities.

In some classes of cutlery the stock will be almost exclusively of English manufacture. Table cutlery will be entirely of Sheffield production. American plated table cutlery has made feeble attempts to find a lodgment on the English market, but its qualities have met the cool reception they deserve. Pocket-knives, except the cheap qualities, will also be English, but the lower grades—especially carded goods, if they be stocked—will be German. English scissors are unexcelled for quality, but American scissor makers supply shaped handle scissors at prices which Sheffield cannot touch at equal price, and they will therefore be patronised for such goods. German scissors may be purchased of fair quality and sold at good long profits.

Razors need not be foreign, although the best German razors are quite equal in value and quality to the best Sheffield instruments. America makes some good shaving implements in the form of safety razors which should be sold and pushed.

Cutlery Brands. Reputation counts for much in cutlery, and the public demand goods bearing the names of makers of repute. The merchant must therefore find what marks are held in the highest esteem, and purchase accordingly. As public opinion varies in different districts, experience in one part of the country is no guide to the requirements of another part. One district, for instance, may demand the name of Rodgers, and another that of Butler.

But the retailer will strive to evade unnecessary selling of well-known brands, and try to build up a reputation of his own. There are many makers of sterling qualities who are prepared to stamp the goods with the shopkeeper's own name and mark, and every blade so marked is an advertisement for the merchant as long as it remains in use. The latter will, however, be foolish if he have any but thoroughly reliable goods stamped thus.

Sets of Cutlery. Recently there has sprung up a trade in cutlery sets. Such sets have always been sold in cabinets, but lately assortments of table cutlery have been offered in cheaper qualities than formerly. The origin of the trade is to be found in the practice of some of the large instalment-payment houses working through householder agents, and those houses have done a fair trade in such goods. But the small merchant should be careful how he stocks these sets. Except for marriage and other presents the demand for them is strictly limited. The lady who requires a few knives and forks seldom has occasion for the other items in the outfit, and even if she has, she usually finds the arbitrary assortment offered not to her liking.

Selling. As the purchasers to whom the tool seller appeals are chiefly of the artisan class, who have to do their buying during the evenings, he cannot afford to put up his shutters in the early evening as many kindred tradesmen can. His hours must, perforce, be longer.

Marking prices of displayed stock in plain figures is desirable. An annual sale is usually a good "draw." It attracts the public, it clears off deteriorating stock—seldom at less than cost prices—and cheap stock may often be bought specially for such a sale. We have seen the corner of a window piled high with many grosses of cheap knives and forks cleared off in a few evenings at good profits.

Profits. The retailer of tools and cutlery may look for an average profit of 33⅓ per cent. on selling prices. Some tools which are sold at lower margin may easily be balanced by other articles with which the public are less familiar, and the average may thereby be maintained. Working expenses should come to between 10 and 15 per cent. of the turnover, and the difference between this proportion and the gross profit shows a satisfactory net result. The stock value of an established business ought to be turned over twice a year, but the beginner, by purchasing often and in small quantities, ought to reach a turnover equal in a year to three times the value of his stock.

CYCLE DEALERS

The history of the cycle trade is a history of vicissitudes, and a few brief sentences regarding the swift changes which have altered its conditions will assist in promoting an understanding of the present problems which confront anyone who would enter its ranks.

The invention of the pedal-driven bicycle created the trade which, during the 'seventies, struggled along by the sufferance of daring spirits willing to risk neck and limb upon a lofty, insecure perch. Cycling was a sport, and cycle retailers were recruited almost exclusively from the sporting class. The introduction of the chain-driven "safety" in the 'eighties widened the trade, as did again the pneumatic tyre some years later, but did not alter the class of men who were the distributing agents.

Skill and strength above the average in causing a pair of bicycle cranks to revolve may be an admirable quality, but it is not necessarily accompanied by business acumen. Thus the men who were engaged in the cycle trade were often void of commercial instinct, lacked commercial experience whatever. They had far better have remained at the vice, pick, or pen, which they had learned how to handle with more or less satisfaction and profit. Most of them were carried off their feet by the few fat seasons when Society decided that to cycle was to be fashionable. The depression caused by Society's change of mind, and by over-production, with the consequent diminution of profits, drew very many of the cycle dealers into the slough of bankruptcy, and many more perilously near it. The weeding out by the operation of relentless economic laws has helped to establish the cycle retailing trade upon a firmer basis than formerly. It has emerged from its years of trial in somewhat chastened mood. The spirit of speculation has been succeeded by expenditure of effort in the circumscribed paths of business routine, and while the cycle agent of to-day may not be able to make money as quickly as he could a decade ago, the road which he travels is much safer.

The Man. The first quality of the cycle dealer must be the mechanical instinct. Not every mechanic or engineer has this mechanical instinct, and many men in other walks of life than those mechanical possess it in a pronounced degree. We have seen a cycle repairer who had carefully overhauled an expensive bicycle, and who had passed it to his customer, claiming that it was thoroughly repaired and in perfect adjustment. The customer spun both wheels, glanced along the frame from the rear, put his hand on one of the pedals for two seconds, taking in several details the while with his eye—the whole inspection having occupied less than a minute. Then he said: "The front wheel

is not quite true, the adjustment of the back wheel is too loose, the frame is slightly twisted to the right, the chain is too tight, and you have put the pad shoes of the rim brake reversed from the proper position, so that they will be pulled out the first time the brake is applied."

In this case the mechanic was sadly deficient in the mechanical instinct, while the customer, who was a member of one of the learned professions, had it in conspicuous measure. This mechanical instinct may be acquired, but hardly. It seems to be largely intuitive. The reason for the need for this faculty is apparent. He who lacks it may endanger the safety, if not the lives, of his customers.

Stock. The cheapening of the cycle has made it possible to put in a good stock at about half the price which a similar stock would have cost a few years ago. Also, the practical standardisation of pattern makes it less risky to carry stock over to another season. The diamond frame seems to have marked finality in general cycle design, and it is a fairly safe prophecy that it will never be departed from. Innovations, such as diagonal frames, serve to furnish copy for the advertisements of the firms who design them, and give the scribes of the cycle press something to write about; but the purchasing public stick to the diamond frame with a persistency that registers good judgment.

Inventive ingenuity exercised in cycle construction now finds scope in multiple gears. A few seasons ago it was free wheels and rim brakes, and the last word of importance seemed to have been said of tyres when the patent application of the endless wire cover was filed.

The selection of stock is not difficult. The standard patterns of any good maker may be accepted with the confidence that they embody the most saleable points, and any deviation from standard pattern usually impairs the all-round chances of disposal.

Prices and Profits. The agency system is all but universal in the cycle trade. Makers grant the exclusive district agency to one retailer, confining their sales in that district to their official agent. This entails mutual obligations. It becomes the duty of the agent to support the maker as well as that of the maker to support the agent. Many agents hold more agencies than they can handle properly, thereby failing to do justice to any one of them.

The agent must remember that cheap cycles are the best sellers, and ought to be cautious in the purchase of expensive machines. The public have come to appreciate the fact that thoroughly reliable cycles at low prices are obtainable, and have generally ceased to credit the claims of the difference in price necessarily standing for difference in quality.

The Cheap Cycle. There has, however, been a retreat from the excessively cheap cycles which manufacturers, under the lead of one large firm, put on the market two seasons ago (at the end of 1904), and between £7 and £8 is now the cheapest model to which makers in the front rank affix their transfers. A machine at this price usually yields to the agent a profit of £2, which represents 33⅓ per cent. on cost price. This may be taken as the rate of profit all over. Many makers now restrict the price at which their cycles may be sold, and this measure has rather cut the stings of the "catalogue agents" throughout the country—men with no stocks, who sold bicycles from catalogues, and who were usually content with a profit of only a few shillings on a machine. To attempt to compete against such men is ruinous for the agent with a business establishment to maintain.

There is no uniformity in cash discounts given by cycle manufacturers. Nearly all are glad to give good terms for prompt payment—most 5 per cent., some only 3¾ per cent. The common monthly terms are 2½ per cent. discount.

In the early days of the cycle trade makers were wont to send cycles to agents upon sale or return conditions. The cycle boom stopped this practice while it lasted, but it has been creeping in again lately. Not many makers do it, and almost none of the first rank. Naturally, the terms under such a condition are not so favourable as when the goods are bought outright. The whole system is bad, and ought to be discouraged.

Motor Cycles. Motor cycles are worth selling. The profits are seldom less than £10 a machine, and £15 upon the better ones. The agent who sells a few motor bicycles in a season has done good business. The makers ask for payment of one-third of the price of a motor cycle with the order and the entire balance upon receipt of invoice, and such terms are supposed to be the rule. But the rule is honoured more in the breach than in the observance—at least in dealing with agents of substance—and there is no good reason why a man of standing should be required to purchase under such one-sided conditions.

In purchasing stock care must be taken not to buy too many ladies' cycles, as their sale has gone down considerably. Tandems and tricycles should not be stocked at all, but sold from catalogues upon occasion.

Capital. In a provincial town it is possible to start as a cycle agent with a capital of £200. It is common, but unwise to do so on less. The £200 will not go far, and the larger the excess above this figure the more probable will success be.

The instalment system of trading is a common feature of the cycle trade. It is risky, and it locks up much capital. But if care be taken to refuse instalment terms to all but those whose record turns out upon inquiry to be above reproach, there is no reason why the trade should not be prosecuted. The prices of machines sold upon instalment or hire-purchase should be not less than 20 per cent. higher than cash prices, and payments should be fixed so that the last instalment shall have been made not later than twelve months after delivery of the machine. As large a first instalment as possible should be secured.

Those whose capital will not permit them to embark on instalment business will find that many of the manufacturers are willing to shoulder the burden of responsibility and to pay the agent the cash profit immediately upon delivery of the machine. Some independent financial firms even do this for the retailer, paying the agent the cash price at once and pocketing the excess as profit. It pays the agent to do the business himself when he can, always selecting his customers.

Accessories. The best paying part of the cycle merchant's business is the selling of accessories. All are not equally profitable, but with a little trouble the dealer can encourage the more profitable of them and discourage the others. Articles widely advertised at cut prices should, of course, be sold as little as possible. The agent is also well advised if he stock accessories of a different make to those sold by his neighbours. Some things, such as a few of the Lucas specialities, he must keep, but he may have the bulk of his accessory stock different from that sold by his competitors, and by this device he may secure much longer prices. The public can seldom judge quality, but they can compare the prices charged by different tradesmen for identical articles.

The stock of accessories will include lamps, bells, wrenches, toe-clips, pedals, brakes, brake fittings, handle grips, inner tubes, a few tyres of standard size, carbide of calcium for gas lamps, inflators and connections, saddles and tool bags, oil cans, oils for burning and lubricating, and repair outfits. There is little outside of this list. The days of fads in accessories have gone with the passing of the society cyclist, and the cycle agent can afford to ignore anything except " bread and cheese " lines.

Profits on Accessories. The profits on cycle accessories are usually about 50 per cent. on cost price, and on special articles double this rate is often possible if the practice recommended above be followed. On certain well-known articles the makers insist that certain minimum prices must be maintained. This practice prevails in the Lucas "cyclealities," for instance, but price maintenance is not so common as it ought to be, so that the large cutting houses do serious injury to the small dealer. The duty of the latter to support firms who seek to preserve the retailer's profit is plain.

Hiring Cycles. The hiring of cycles is a department of the business which has had its day. Many hundreds, perhaps thousands of cycle agents have surrendered this branch after long and costly experience. There is smaller occasion than formerly for cylists to hire cycles. When a good bicycle can be purchased for, say, £6 to £8, the man who would pay the cycle agent's charge for hire, unless in exceptional circumstances, is more than foolish. Hirers of cycles are usually the most careless of the cycling public, and it is often impossible to secure payment for damage to machines hired. The cycle agent has no use for hirers by the hour. They give more trouble than profit. The only kind of hiring which may be done with expectation of reasonable return is that for the season, or for at least a month, the charge for which is usually about £2. If the machine be well cared for by the hirer, and it be on hire for, say, four months during a season, its cost price has been almost or quite recovered, and, as it stands, it represents the profit of its own hire for the year. Above all, it does not pay to let on hire cycles of second-class quality. The best are always the cheapest for this purpose. It matters nothing if they are last year's models, or even those of the year before, but they must be of sterling quality.

Repairing. The cycle merchant who does not repair cycles neglects the most remunerative part of the business. Nothing helps the selling of cycles like the ability to repair them. Buyers like to purchase new mounts from the man who has kept their old machines in repair. If his repair work has been satisfactory, he is properly held to be a good judge of what a cycle ought to be, and his advice regarding the new machine is usually asked and frequently taken.

The Workshop. The equipment of the cycle agent's workshop is not expensive. The essential tools are a brazing forge and blowpipe, a wheel-truing frame, a vertical drilling machine, an erecting stand, a small hand spoke-screwing machine, some tools such as pliers, wrenches, files, soldering iron, dies and taps, an assortment of spokes, nuts, bolts, cones, pedal pins, and a few less important items. The sum of £20 will purchase the whole outfit, although, if another £10 note can be devoted to this department, so much the better. The brazing forge assumes that a gas service is available. If not, a brazing apparatus with oil fuel must be purchased. The drilling machine will be driven by hand or foot power, but as the business develops a small gas or oil engine, a turning lathe, and a buffing machine may be installed.

An enamelling stove is almost a necessity. Let the man build it himself. It is attended with no difficulty, and it can thus be installed at half the price it would cost to purchase and erect it. The enamelling stove should not be too small. The gas for a small stove costs almost as much as that for a large one, and the former will not permit of exceptional work, such, for instance, as the stove enamelling of a tandem frame.

Plating Plant. Only a very large cycle business can support an electro-plating plant, and the cycle agent is seldom wise to instal one. The cost of doing so is about £100. Good workers for plating are difficult to get, demand high wages, and many of them are notoriously unsteady. He who embarks upon this department will not have far to look for his troubles. Plating must be well done to secure acceptance, and it can be well done only when the baths are kept in regular and continual employment, and after long experience of the work.

Manufacturing Cycles. It was formerly the practice of cycle agents with workshop facilities to build cycles from cycle fittings

purchased from the makers of such goods, during the winter months. The practice still prevails to some extent. Two reasons stood sponsor for its wisdom. It enabled the agent to pose as a maker, although he was a maker by courtesy rather than in fact; and many prominent cycle manufacturing businesses were begun in this manner. The public have a liking to treat direct with a *maker*, imagining that they save thereby an intermediary profit. The second reason was that it provided work for the workshop staff during the "off season," and enabled the employer to retain the services of good men season after season by giving them constant employment. Even if the cost of manufacturing cycles were as high as the price of similar machines purchased from Coventry or Birmingham, there was economic profit in "assembling" cycles, as manufacture by retailers has often been called. But specialisation of manufacture and the heavy falls in the prices of complete cycles during recent years have made it impossible that the small local man can prosecute this branch of his business with profit. He can now purchase cycles far more cheaply than he can make them, and the attendant advantages of manufacture are not great enough to outbalance the higher price. It has, therefore, come about that the agent can no longer manufacture with advantage, and he ought to seek other outlets for his efforts during the months when cyclists refrain from troubling him.

The Need for Side Lines. A few years ago, when the profits of merchanting cycles were large, and before every other shoemaker and greengrocer was a cycle agent, the summer trade in cycles served to support the deadweight of the quiet winter months. These halcyon days have passed never to return, and it is now recognised that selling cycles alone is not a promising road to fortune. Profits per machine are now only half what they were, or even less, and there are many more individuals offering their services to the cycle-buying public; hence, to dispose of the same number of cycles per season as formerly yields less than half the net profit. Retailers, whose main business has lain in cycle-selling, have tried many different branches to eke out an income. The best side lines are naturally those which are in demand during the late autumn and winter months, when cycles are not wanted. This makes the selling of incandescent and other gas fittings particularly suitable for exploitation by the cycle agent. A few years ago this fact was recognised by the directors of one of the principal gas-mantle making companies, one of whom had on his wheel carried off many of the laurels of the road and racing path, and the cycle trade were encouraged to stock and push incandescent gas fittings. Those who did so made good money as the result, and the experiment led them into other branches of business. It is not yet too late in the day for others to follow suit, as the demand for such things is permanent and large, and their sale is very profitable. Mantles can be sold well at 50 per cent. profit on cost price, and the cheapest varieties are not the least lucrative.

Electric Fittings. Electric fittings are other things which may well assist the cycle dealer's annual trading account. The selling of electric fittings leads to the fitting of electric bells, electric lights, and private telephones, and although it is generally supposed by the uninitiated that there is something mysteriously technical in electric work, it is not so. Textbooks upon the subject of electric fitting are numerous, and the wholesale houses who supply the accessories are always pleased to advise customers when difficulties are encountered. In both the selling and the working departments electric work is profitable. No doubt competition by many municipal authorities makes this department a little unpromising in many towns, and municipal trading is on the increase, but there are very few places where a venture into the field of electric work will not assist the business of a cycle dealer. [See Electric Dealers.]

Other Side Lines. Baby carriages, sewing machines, domestic laundry-machines, guns and ammunition, fishing tackle, toys, and general sporting goods are often sold by the cycle dealer. Particulars of stock, capital, and probable profits in each of these departments will be found in other articles in this course. Many of them are in the height of their season when the trade in cycles is at its busiest, so that the pressure is increased at an inopportune time, but this circumstance cannot be avoided; and as competition becomes more keen, and drives to adventure into other branches, the cycle merchant, if he be wise, will try to exploit that for which his district seems the best suited.

The Cycle Show. The Stanley Cycle Show still lives, although the great competing exhibition has died a natural death. The practical uniformity of design which cycles have now reached makes less necessary than formerly a visit to the Cycle Show, but it is instructive still, and a visit is essential for the cycle retailer who would keep abreast of the times in cycle construction and in the novelties which each season brings forth. The Stanley Cycle Show is held each year in November at the Agricultural Hall, Islington, London. It runs for eight days, from the Friday when it opens until the evening of Saturday on the following week. Provincial visitors can usually secure special cheap fares, arranged to cover a few days' visit.

Continued

YARN MANUFACTURE

Thinning the Sliver. The Drawing of Cotton, Wool, Flax, Hemp, and Jute. Details of Machines and the Processes in Manufacture

Continued from page 2000

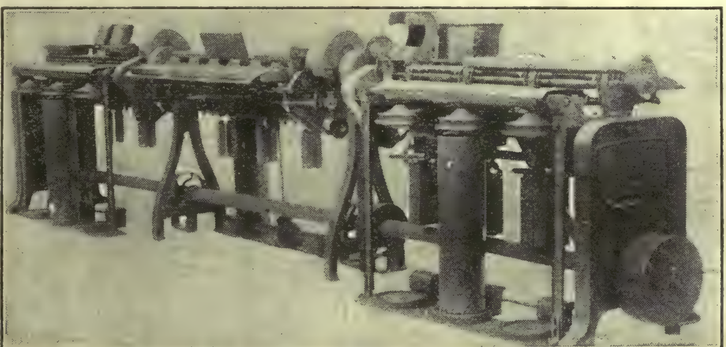
By W. S. MURPHY

BY the various methods and machines studied up to this point we are able to produce from any textile fibre the soft, thick rope technically named the sliver. Each trade has its special ways and means, but the object of all is the same. To cotton, woollen, worsted, waste silk, ramie, flax, hemp, and jute workers alike the sliver is the indispensable beginning of yarn. The only maker of fabrics exempt is the felt manufacturer; he does not need the sliver because he does not use threads. Neither does the sliver trouble the woollen cloth manufacturer very long, but for a different reason. Inquiry into this matter may yield us important knowledge.

Thinning the Threads. The woollen sliver has been taken direct from the carding engine, and formed on the condenser into a thick thread, which is finally to be spun on the mule. When it comes off the condenser, the woollen yarn has some of the defects of the sliver. It is rather loose and fluffy, and the fibres are all felted together. This will do fairly well for a thick thread, and is bound to make a very soft, woolly cloth such as the woollen manufacturer professes to make; but for a fine, light cloth, or hosiery yarn, it would never do at all. If thinning out, elongating, and compacting the sliver into a thread were our only object, then every textile worker would use a form of condenser, and discard half the spinning machinery at present in operation. But a very different thread is required for worsteds, carpets, hosiery, calico, zeyphers, muslins, lace, silk, yarns and cloths, linens, damasks, canvas, and even ropes. The general requirements are these: (1) Uniformity throughout the whole of the yarn being made; (2) a thread composed of fibres drawn out to the utmost length and laid parallel; (3) a given length of thread to a given weight. It may be truly said that such have been the aims of the carder, spreader, and comber; but it is one thing to have aims and another to accomplish them. On the carding engine the fibres may lie even and yet be doubled; to obtain continuity of sliver in spreader and combing machine the fibres have been overlapped; parallelism has not anywhere been fully assured. For these reasons the drawing frames are called into requisition. So important did Arkwright deem this operation that when defective yarns were brought to him by manufacturers seeking his advice, his first question always was: "Do you mind your drawings?"

Cotton Drawing Frames. The cotton drawing frame exhibits better than any other the fundamental principles of the operation, and it may therefore be studied first.

In the factory the frames stand ranked in rows, one scarcely divisible from the other; but these so complex and formidable looking machines are merely aggregations of one simple drawing apparatus. Taking one single section of the drawing frame, we find it consists of four pairs of rollers, several guide holes, guide plate, and driving gear. The bottom rollers of each pair are fluted sections of rollers extending the whole length of the frame, the spindles fixed in toothed wheels working on the drive. The top rollers are single, clad with leather or smooth felt, and set in holders from which depend weights to give them the necessary pressure. On the old drawing frames, wooden guards, lined on the under side with flannel, act as clearers to the top rollers; but in the newer frames, which we illustrate [26] the clearers are rollers revolving beside both top and bottom rollers. The guide plate has upon it curved grooves tapering to a point for conducting the slivers to the rollers, and upon it works a wire apparatus, which acts upon the drive of the frame. As they pass, the slivers keep this wire in position, but when a sliver breaks or becomes entangled the wire falls and stops the machine.

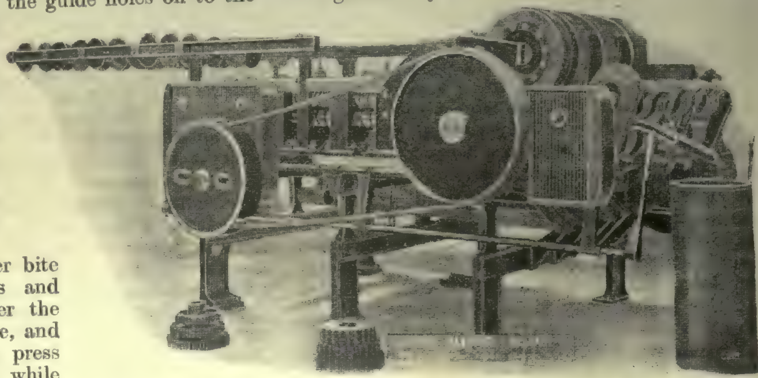


76. COTTON DRAWING FRAME (Platt Bros., Ltd., Oldham)

Functions of Drawing Frames. The drawing frame is a product of the highest genius, and it is therefore simple and marvellously efficient; the slight mechanism performs several functions at one time. It is this complexity of function which makes the drawing

frame rather difficult to understand. The machine combines several slivers into one, lengthens them, and draws the fibres composing them straight. As our habit is, let us watch the machine at work, and then discuss the performance.

Six sliver cans are set behind the section of the drawing frame we elect to study, and the ends are led through the guide holes on to the guide plate, where they are united and drawn in between the first pair of rollers. By the guide holes the slivers, which have a tendency to lump and cling in folds, are kept single. The edges of the flutes of the first under roller bite upon the soft ropes and draw them in under the weighted roller above, and between them they press the slivers into unity, while letting them out to the next pair of rollers in the form of a thick rope.



77. FLAX DRAWING FRAME (Combe, Barbour & Co., Belfast)

Our second pair of rollers are running at a higher speed than the first, and draw out the sliver; the third pair has a higher velocity, and the fourth pair a higher speed still.

The Value of Speeds in the Process. The ratios of speed between the various rollers must now be observed. Say that the first pair of rollers are running at the rate of 60 ft. per minute, the second pair must not be run at a too high speed, or the sliver will be broken; but they must exercise a drawing force, and at the same time feed the next pair with the sliver. Let the speed of the second pair be 80 ft., the third pair 120 ft., and the fourth pair 240 ft. per minute. We have thus a gradation which brings the speed of the last rollers up to four times the speed of the first rollers. In practice the gradations vary; but our main point is that there is gradation, and that the speed of the last rollers is generally from two to six times quicker than the speed of the first. The effect in the former case is to produce a sliver one-third heavier than any one of the original slivers, but firmer in consistency, and with the component fibres straighter.

Adjustment of Rollers to Suit the Cotton. Not only have we to consider the ratios of speed, but we must also observe the spaces between the rollers. This is determined by the length of the fibres. A cotton averaging 2 in. length of staple would be nipped and broken if the rollers only sat three-fourths of an inch apart; on the other hand, a short-stapled cotton sliver would be parted and rendered irregular if the rollers were placed too far apart. The grip of the fluted rollers is no make-believe, no mere passing-on movement, but a firm hold meant to give a pull. Were it otherwise, the chief purpose of the drawing frame—*viz.*, the straightening out of the fibres—would not be fulfilled. But the ends of the fibre at no time lie evenly together; the one fibre overlaps the other, even after we have done our utmost to bring them parallel. This is comparatively true; therefore the spaces between the rollers should be rather longer than the average length of the staple than shorter.

A good many other points might be profitably discussed. For example, hard, wiry cotton should be subjected to harder drawing than soft, flexible fibres. But our course of study is too general to permit the consideration of such details.

Our drawn sliver is next combined with other five or seven similarly drawn, and put through another drawing; this is again repeated. By this doubling and redoubling the slivers are brought thoroughly to uniformity. In spinning very fine counts, we have as many as six drawings, in the following ratios:

$$\frac{8}{1} \quad \frac{4}{1} \quad \frac{7}{1} \quad \frac{6}{1} \quad \frac{6}{1}$$

Multiply together the numerators, which indicate the number of slivers united at each drawing, and you have a total of 48,384 doublings. This is surely enough to delete all difference, and yet, as we shall see, it is not the last doubling.

Wool Drawing. If, in the multitude of counsellers there is wisdom, it is also certain that in diversity of advice and practice the learner is confused. Nowhere does the need for scientific classification and system appear more prominently than here. Attenuation of the sliver appears a definite enough operation, and yet it is not accurately defined in textile practice. What the cotton worker calls *slubbing*, the worsted man calls *drawing;* the jute and linen manufacturers give the term *roving* to the operation, which is only a part of drawing to the worsted worker and slubbing to the cotton spinner.

If this were all, some excuse might be offered. Different industries develop on different lines, and each one has a right to its own system. But the worsted industry has no uniformity within itself. Some run the slivers through one drawing frame, and at the second wind the

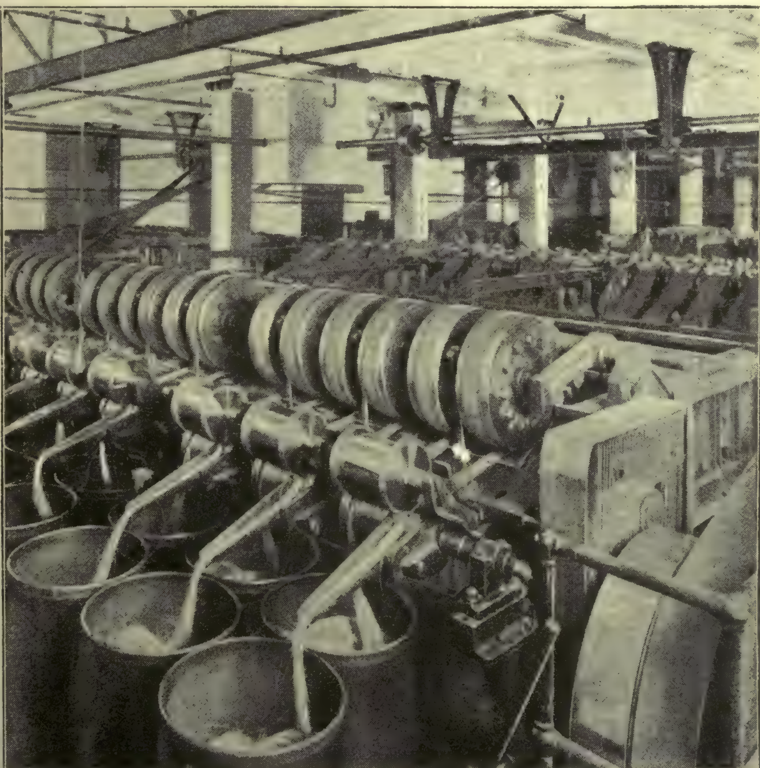
drawings on to bobbins; others use bobbins at the fourth drawing. In a process so continuous and regularly graded as yarn manufacture, it is necessary to mark clearly and distinctly the points of departure, the moment when the method of working changes, or when a new instrument comes into play. We hold strongly that the moment a bobbin, with its gearing of flyers, comes into play drawing, pure and simple, has ceased and spinning has commenced. To bring in at the end of drawing, as a kind of after thought, an important principle like that of the bobbin and flyer is to invite carelessness towards a vital process.

Details of the Process. Whatever system of nomenclature or working may be adopted, the first drawing after the sliver has been taken from the combing machine is done on the gill box, which is nothing more than a finer model of the one we studied in the process preparatory to the combing machine. That there may be no mistake, we shall recapitulate briefly the working of the machine. As many slivers as it has been resolved to combine are brought to the fore end of the frame. Here we encounter a variation in practice of small importance, but to be noted. Some manufacturers feed the drawing gills straight from the cans, but others form the slivers into balls; alternatively, the sliver is balled on the combing machine, a practice coming more and more into favour. Instead of the moving lattice, our feeding apparatus is a set of pulleys, which combine the slivers and send them directly into the first of two pairs of fluted rollers which act as feed rollers. When the sliver issues from the feed rollers, it is seized by the faller combs and carried on to the drawing rollers, which are smooth but otherwise similar to the rollers on the cotton drawing frame, the upper roller being borne down on the lower by weights or springs. Thence the slivers are coiled into cans again.

The drawing is effected in the following way. The gills, or faller combs, drawing more quickly than the feed rollers supply, pull out the sliver; the drawing rollers revolving four, five, or six times more quickly than the front rollers, attenuate the sliver still further. By the combing of the gills and the drawing of the rollers the fibres are straightened, drawn, and laid parallel; by the doubling the slivers are solidified; by repeated doublings we obtain uniformity of thread.

Flax and Hemp Drawing. The drawing frame of the linen manufacturer differs in no essential particular from that of the worsted worker; but he has his own way of using it. When the slivers came off the spreader we saw that they were weighed and the weight marked on the cans, and now the use of that practice becomes evident. Before we have done drawing, we ought to possess as many thick threads as we require, all of one weight and length. By the bell at the end of the spreader we have made sure that the lengths of the slivers are equal; but the weights are still rather irregular.

In the flax drawing frame we require to consider the combs collectively; it is not enough to watch one range of combs. Take the first or "set" frame, as it is named. On this frame [77] we have, say, six combs on each bar, which will form six drawn slivers. As we start by doubling the slivers derived from the spread-board, a set will be twelve cans. The aggregate weight of the slivers of these cans must be the



78. DRAWING FRAMES PREPARING HEMP FOR SPINNING

weight of the combined slivers. If one sliver is 7 yd. per lb. and another is 9 yd. per lb., the two combined will give 8 yd. per lb., if undrawn. But our drawing lengthens the sliver four times, and the result is a sliver 32 yd. per lb. In actual practice the calculations are more complex, but the principle is the same. On the second drawing frame the slivers from each set are again doubled, according to the principle of combining different to obtain equal weights. The same rule is followed on the third, and, when necessary, the fourth, drawing frames, so that at the end we have a range of slivers, or slubbings, all of equal weight to length, and straightened in constituent fibres.

Variations in Practice. Some variations in practice and common mistakes in working may here be noted. For very fine linen yarns the slivers from the set frame are kept apart, and doubled on the next frame ; but hemp fibres and flax for heavier yarns have the slivers doubled again at the back of the machine, or, it may be, the whole set may be combined into one and coiled into one can. We have not yet been able to adopt the automatic stop motion of the cotton drawing frame, for a variety of reasons too minute to be detailed at present. In consequence, the failure of one of a pair of slivers is no uncommon occurrence. *Singling*, as the fault is called, may occur in spite of close attention. Perhaps a part of one of the slivers is too thick to pass with its neighbour under the pressure roller, and sticks, while the other passes on. The feeding looks all right, for the ends of the pair are in the machine, though only one is going forward. If the other gets started again before the attendant's suspicions are aroused, the singling will pass undetected till a few stages further on. When an accident may happen without fault on the part of anyone, it must be evident that many occur through preventible causes. Fig. 78 illustrates a corner of the drawing department in a hemp mill.

The Jute Sliver. The drawing of the jute sliver might be studied fully on the flax-drawing frames. But there are some differences which must not be passed over. The first drawing frame of the jute sliver is much larger than that used for flax ; the rollers are heavier, and the gills are stronger. We can hardly say that this is because jute is a harsher fibre, but rather think it is because of the longer fibres, which require more room and a greater leverage.

Jute frames are run in sets of two, three, or four carriages. The best work is got from the double frames — that is, frames of two carriages. Four combs on each bar of the two carriages, and a double sliver to each comb, makes a set of 16 cans to the frame. If each single sliver weighs 10 yd. to 1 lb., the double sliver will give 5 yd. to the lb. Given that the draft of the drawing is 6 to 1, the sliver delivered should weigh 30 yd. to 1 lb. But it is considered good practice, with a view to reducing the inequalities of the slivers, to lead them in pairs over the guide plate into the delivery rollers, and so produce a sliver 15 yd. to the lb. These slivers are taken to the second drawing frame, there to be doubled and passed through finer combs, in preparation for the next process.

Various Slivers. The slivers of waste silk, ramie, and other fibres, scarcely require special study in this stage. Most commonly the longer fibres are drawn on the gill frames, and the shorter fibres are treated like cotton. No new principle or method is involved, though it would be rash to say that no adjustment of the machines is required. But the latter is a practical problem, which can be dealt with only in regard to a particular sliver or set of slivers. The machines best suited for dealing with waste silk and ramie will be more easily understood in the next stage of our study.

Continued

A STUDY OF SOUND

Nature of Sound. The Echo. Sound Waves. Noise. Pitch. Harmony. The Scale. Resonance and Vibration. The Human Voice

Continued from page 2064

By Dr. C. W. SALEEBY

FOR convenience we shall use the word *sound* to indicate the external fact which gives rise in us to the sensations of sound; but meanwhile we must recognise that if there were no ears to hear there would be nothing such as we understand by sound. Apart from the hearing subject, all nature is silent; just as, apart from the seeing subject, all nature is in darkness. One kind of wave-motion, falling upon one kind of nervous structure, produces light; another kind of wave-motion, falling upon another kind of nervous structure, produces sound.

Our first assertion, then, is that sound is a wave-motion. In familiar instances, as in the case of a bell, we are aware that the body which emits the sound is itself, as we observe when we touch it, in a state of vibration. And we can easily convince ourselves by experiment that the essential consequence of such vibrations is to produce disturbances in the medium surrounding the vibrating body. Commonly, that medium is air, but it may be any other substance that possesses elasticity. The essential part played by the air in ordinary cases of the transmission of sound may readily be shown by sounding a bell within an air pump, and then gradually reducing the quantity of air surrounding the bell. When a certain rarity of the air is reached, the sound of the bell ceases, since there no longer remains sufficient air surrounding it to transmit its vibrations.

The Speed of Sound. Every kind of wave requires a certain amount of time for its transmission. This is true of the waves in the ether, which constitute radiant heat and light and electricity. These all travel at one and the same unchangeable speed. As everyone is aware who has watched cricket or firing from any distance, the speed of these ethereal waves is far greater than that of sound. One sees the bat hit the ball, or the puff of smoke appearing, appreciably before one hears the corresponding sound. The speed of sound can readily be calculated, and, unlike the speed of ethereal vibrations, is found to vary according to the state and properties of the medium which transmits it. The speed does not vary markedly, however, with the pitch of the sound, which we shall shortly study, nor yet with its loudness—facts which are fortunate for the musician.

All sounds travel through air at a speed of rather more than 1,100 ft. per second, the speed increasing somewhat with the temperature of the air. The reason of this is found in the fact that such a rise of temperature increases the elasticity of the air, and it is upon this factor that the speed of sound in any medium depends. The speed of sound in other media than gases has also been studied, as also the relative ease with which such media transmit it. We know that the earth will transmit sound more efficiently than the air above it; this every boy knows who has read of the exploits of the Red Indians and the ease with which they acquaint themselves with the approach of their enemies by putting their ears to the ground. In general, sound passes much more rapidly through solids than through liquids, and through liquids than through gases, including, of course, the air. Thus, sound travels through iron about seventeen times as fast as through air.

The Intensity of Sound. The intensity of sound varies according to a law with which we must now be familiar, since it holds true for radiant heat, for light, and for gravitation. The law is that *its intensity varies inversely as the square of the distance.* This is familiarly known as the *law of inverse squares,* and is true of wave-motions in general. But the intensity of sound varies also with another factor which has not to be reckoned with in the case of ethereal wave-motions; and that is the density of the medium which transmits it. We know, for instance, how clearly sounds are heard on a frosty night, the reason being that the air is then more dense; while a famous Alpine traveller mentions that the report of a pistol at a great elevation appeared no louder than would that of a small cracker at a lower level.

Just as other wave-motions are reflected, as we saw in the case of radiant heat, so are those which we interpret as sound. The laws of such reflection are the same as those that regulate the reflection of light; and, indeed, are the same as those which (ideally) determine the reflection of a billiard ball from a cushion. The angle of incidence is equal to the angle of reflection, and, we must add in the case of sound, the planes of incidence and of reflection coincide. These laws are equally true for the reflection of light and radiant heat.

Everyone who has ever heard an echo is aware of the reflection of sound. Echoes sometimes offer serious practical problems, since they may seriously interfere with the utility of a hall for music or public speaking. In order to correct this defect it is necessary to break up in every possible way all the sound-waves except those which actually travel directly from speaker or performer to the audience. Wires and tapestries, and, indeed, the bodies of the audience themselves, are often found to be of value.

Use of an Echo. But the principle of the echo may also be utilised in a rather surprising way. If the sound be reflected from more than one surface there will be a series of reflections, or echoes, which will remarkably modify the

ordinary facts of its transmission. A familiar and conspicuous instance is furnished by the whispering gallery of St. Paul's Cathedral. Similarly, sound may be reflected from smooth sheets of ice, as in the case of two Arctic explorers, who conversed comfortably at a distance of a mile and a quarter. The principle of repeated reflection is adopted in the ear trumpet, the speaking trumpet or megaphone, and in all kinds of speaking-tubes. The most striking natural instances of echoes are furnished by peals of thunder.

Refraction of Sound. Just as light waves, as we shall afterwards see, are bent or refracted on passing from one medium to another, so also are sound waves. In the case of light and radiant heat, we have to remember that the wave is passing through one and the same medium all the time ; but in the case of sound the wave is actually transmitted from, let us say, the air of one room to the wall of another, and so to the air of the next. But in such cases the direction in which the new wave travels is different from the previous one. This change of direction is indicated by the term *refraction*, and it follows the same laws for sound as for light, under which they will be discussed. Just as light—in virtue of refraction—may be brought to a focus by a convex lens, so also may sound by the employment of some medium which will refract it. A balloon filled with carbonic acid gas, for instance, will bring to a focus at a definite point on one side of it the sound of the ticking of a watch placed on the other side of it. If the balloon be made to swing from side to side, as in the case of an experiment of Lord Rayleigh's, the demonstration is still more striking.

Nature of Sound Waves. We have already noticed one fundamental distinction between the waves of sound and those of light—*viz.*, that the former are waves in a material medium (which may be gaseous, liquid or solid), while the latter are waves in the ether. But another most important distinction is that these ethereal waves or vibrations are at right angles to the line in which they advance. They are described as transverse vibrations. But the waves of sound are longitudinal vibrations. The particles of air, or whatever the medium may be, travel to and fro in the line in which the whole wave is advancing.

Now, a most important distinction between these two waves—transverse and longitudinal—is that the latter, unlike the former, bring the particles of the medium alternately nearer to, and farther from, one another than they are when undisturbed. Such waves are thus waves of alternate condensations and rarefactions. Perhaps one of the best ways in which to obtain an idea of such waves is to think of a row of billiard balls in contact with one another; the ball at one end being struck by another ball rolling up against it. The balls, being elastic, like all media which transmit sound, are alternately compressed and recover themselves, with the ultimate result that the ball at the end of the row is shot forward by itself. In just such a manner must we imagine the particles of air to behave when transmitting sound.

Noise. But there are sounds and sounds, as everyone knows, and though opinions differ as to the precise point where the line should be drawn, there are two great classes of sounds between which our ears detect so marked a difference that there must surely be some objective difference, equally definite, between them. Sounds we may divide into noises on the one hand, and musical notes on the other. What is the difference between them ? This question can be clearly and positively answered. The vibrations which we interpret as noise are irregular, while those which we interpret as musical notes are regular. In observing this fact, we make a most important contribution to psychology. The psychologist asks why one sound is pleasing and another unpleasing ? As physicists, we reply that, while ignorant as to the manner in which hearing is effected, we know the pleasing sound to be determined by regular stimulation of the nervous structures by which we hear, while unpleasing sounds, those which have not the musical quality, are determined by irregular stimulation. We need pay no further attention to noises of any kind, but must now devote ourselves to the study of musical notes—the fashion in which they are produced, and their relations to one another.

Pitch. The most striking respect in which musical notes differ from one another is in pitch, and it is easy to ascertain by what this is determined. It depends simply upon the number of shocks upon the ear per second. A tuning-fork, for instance, can be made to record its vibrations upon a piece of smoked paper passing in front of it, and we find that the pitch of the fork depends upon the rate at which its prongs vibrate. For any particular tuning-fork this rate is constant. As we listen, we hear the sound gradually die away ; but the wavy line upon the smoked paper shows us that the number of vibrations per second does not vary ; while our ears tell us, in point of fact, that the pitch remains constant even while the loudness diminishes.

The matter of *loudness* is so simple that we may dismiss it here. It depends merely upon the size of the waves, their extent, or, to use the technical phrase, their *amplitude*. The behaviour of the ear, however, somewhat complicates this statement, since Helmholtz, the great German physician, physicist, and philosopher, observed that the notes differing in pitch differ also in loudness, even where the amplitude of vibration is constant, the higher note always exhibiting the greater intensity. This is simply to say that, other things being equal, our ears are more sensitive to high than to low tones; but, in the case of any given note or tone, its loudness depends simply upon the amplitude of the vibrations which constitute it. So much for loudness. The essential fact of pitch we have already determined to be the rate of vibration. Various instruments have been devised for proving this assertion, and also for elucidating the facts of harmony. There is,

for instance, what is called the toothed wheel apparatus of Savart; but that has now been superseded in practice by another device.

The Siren. This is the name of an apparatus by which a continuous flow of air through a tube is arrested and permitted at regular intervals by means of a revolving disc, near the edge of which are a number of holes at equal distances from each other. These holes come in succession opposite the end of the tube, and permit the air to escape. In a more complicated form of the same instrument there is an arrangement by which the speed at which the disc rotates can be readily measured.

When we experiment with such a siren, we find that the note which it produces rises or falls according as we increase or diminish the speed at which the disc rotates. But it also gives us much further information. In the first place, it gives us the limits of hearing for any individual—limits which are precisely comparable with those of sight. When the number of puffs per second is 10, let us say, individual puffs may be heard, but there is no note produced. As the speed of the disc increases, however, a note is heard, perhaps when the puffs reach the figure of 16 per second. The first note heard has, of course, an extremely low pitch, but as the number of puffs per second increases the pitch rises, until at last it becomes extremely shrill, and finally is lost altogether. The number of vibrations beyond which no further sound is heard may be 30,000 per second or 50,000 or 70,000. The figure varies with different individuals, and is also affected in any individual by the occurrence of various kinds of deafness. The upper limit of hearing, for instance, may be very much reduced in cases of what is called *nerve-deafness*, where the disorder is due not to the conducting apparatus, but to the nervous centres themselves. Thus the siren may be of considerable medical importance. It is very probable that sounds too shrill for most or for all human ears may be perfectly audible for some of the lower animals.

The Harmony of the Siren. In order to study harmony by means of the siren, Dove, of Berlin, has modified the instrument, piercing four concentric sets of holes in the disc, the number of holes having, for instance, such a ratio as 8, 10, 12, 16. He calls this the *many-voiced siren*, and can cut off any particular circle of holes at will, thus making the instrument speak with any combination of its voices. It is then found that if the eight and sixteen-holed circles be left open, two tones are heard, one an octave above the other. If the speed of rotation of the disc be accelerated or reduced, the tones are proportionally sharpened or flattened, but the one always remains the octave of the other, proving conclusively that the relation between a note and its octave depends upon the fact that the speed of vibration is exactly twice as fast in the one as in the other. Now, the ratio of 8, 10, 12, and 16 is the ratio of 4, 5, 6, and 8, and if all the circles of holes be left open, that is the ratio between the four notes which are produced. These are the notes of what musicians call the *common chord* or *fundamental chord* C E G C′. If the first and third series of holes be left open, we find that the note having the ratio of 6 to 4 or 3 to 2 is a fifth higher than the lower note. The G on the piano thus has half as many vibrations again per second as has the C below it, the ratio being that of 6 to 4 or 3 to 2. Similarly, we find other musical intervals established by sounding other combinations of the circles of holes, and it is an easy matter to establish the ratios of all the notes in, for instance, the ordinary major scale of C. Thus:

$$C : D : E : F : G : A : B : C'$$
$$1 : \tfrac{9}{8} : \tfrac{5}{4} : \tfrac{4}{3} : \tfrac{3}{2} : \tfrac{5}{3} : \tfrac{15}{8} : 2$$
$$(\text{or, } 24 : 27 : 30 : 32 : 36 : 40 : 45 : 48)$$

The Scale. The most important fact about such a scale is the constancy in the ratio between its notes. In fact, we must state, as follows, the fundamental law of musical harmony. *The notes employed in music always correspond to certain definite and invariable ratios between the vibration numbers of the notes; and these ratios are of a very simple kind, being restricted to the various permutations of the first four prime numbers*, 1, 2, 3, 5, *and their powers.* This fact is the whole essence of music, not only of harmony but of melody also. All the notes of any tune must lie in a definite scale, the nature of which is determined by the strictest mathematical considerations. Music is thus a variety of applied mathematics. If a note be sounded which does not possess one of these due simple ratios to the other notes of the scale, we say that it is out of tune—*i.e.*, it is either *flat* or *sharp*. The note may have pleasant enough quality in itself, but it has no relation to the rest of the notes of the piece. It simply cannot occur in such a place. This fact is quite distinct from all questions of discord. Almost any discord is permissible in its place in modern music, but all the notes so sounded have, at least, their regular places in the scale, whereas a note which is "out of tune" has no such place. The various notes of the scale quoted above constitute what is technically known as the *natural* or *diatonic* scale.

The intervals between successive notes upon this scale are either major or minor tones or semitones, the third and the seventh belonging to the latter class. If we insert an additional note between each pair of notes whose interval is either a major or a minor tone, we obtain a sequence of twelve notes, the intervals between each successive two of which are much more nearly equal than those of the notes in the diatonic scale. This more complicated scale is known as the *chromatic* scale. The distinction between the older music and the music which is most prominently represented by Wagner may most simply be stated by saying that the older music is founded upon the diatonic and the newer upon the chromatic scale.

Stretched Strings. The facts which can be so easily proved by the siren can equally well be demonstrated by several other means. Notes of varying pitch may be produced, for instance, by the vibration of stretched strings.

Certain conditions determine the note which is produced by any given string, these being its length, its mass, and its tension. The term *mass* covers two factors which may vary independently—the thickness of the string and its density. The simplest of these factors to understand is the length of the string. If a string, as in a violin—its tension being kept invariable—has its length altered, its fundamental note (we shall afterwards explain the meaning of the word fundamental) will rise in pitch in exact proportion to its diminished length. In this fashion, the diatonic scale can be played on one string of the violin, by stopping at intervals corresponding to the notes required.

Tension and Pitch. The relation of the tension of a string to its pitch is rather more complicated. Other things being equal, the note is proportional to the square root of the tension—that is to say, if the tension be multiplied by four, the pitch of the note is multiplied by two—it is raised an octave. Again, the note of a string varies inversely as the square root of its density, and inversely as the square root of the weight of any given length of the string. There is no simpler arrangement for studying these facts in the case of strings than the monochord, which was known to the Greeks and carefully studied by them. This is simply a single string stretched between two fixed points over a sounding-board. Between the ends of the string is a movable bridge, by means of which the vibrating length of string can be modified. For instance, if the movable bridge be inserted half-way along the string, the result is a note an octave higher than when the bridge was absent, and so on. So far as we have gone we find that the facts agree entirely when we turn to the notes produced by pipes instead of strings. Other things being equal, a pipe of eight feet in length will produce a note an octave higher than a pipe sixteen feet in length.

Fundamentals and Over-tones. But we find a great deal more complexity in, for instance, the vibration of a stretched string than has hitherto been indicated. The string, it is true, is vibrating as a whole, but it is also vibrating in segments. The same is true of a column of air in an organ pipe. The note produced by the vibration of a string as a whole is known as its fundamental note or tone. The notes produced by its simultaneous vibration in parts are known as *over-tones* or *harmonics* or *upper partial* tones.

These over-tones are of immense interest and importance from every point of view. We have already noted one or two characters in which one musical tone or note differs from another—characters such as pitch and loudness. But there is another character, at least of equal interest, which is quite independent of both of these, and that is the quality or *timbre* of the note. Various words have been used for expressing this quality. Sometimes we employ in English, the word *clang-tint*, a translation of a German term. Any two tuning-forks sounding notes of the same pitch and loudness are absolutely indistinguishable from one another. The reason of this is that the note produced by a tuning-fork is a simple tone containing only one fundamental note without any harmonics or over-tones.

How Notes and Tones are Identified. This fact, then, leads us to understand how it is that we are able instantly to distinguish identical notes, or what purport to be identical notes, according as whether they are produced by a piano, a violin, a clarionet, the voice of one friend or the voice of another. We say these notes purport to be identical, and, indeed, their fundamental tone is identical. The differences which enable us readily to distinguish them so are entirely dependent upon the number, character, intensity, and intensity relatively to one another, of the various over-tones which accompany the fundamental note in every case. If these be few, the tone is thin and lacking in beauty; if they be very numerous and prominent, the tone may be very heavy; and sometimes, as in a very rich and resonant bass voice, the identity of the fundamental tone is actually obscured. The finest tone is that which includes the largest number of over-tones, or harmonics, that form a fine harmony with the fundamental tone. If the over-tones form an unpleasant chord with the fundamental tone, then the voice or violin, or whatever the instrument may be, is held to be unattractive.

Resonators. Everyone knows how a sound produced by any means is reinforced under certain conditions. Illustrations are furnished by a watch lying respectively on cotton-wool or on a hard table, and by a tuning-fork held in the air or having its stem firmly placed upon a table. The string of a piano produces extraordinarily little sound when struck unless it be aided by a sounding-board. If the belly of a violin be removed for experimental purposes and the instrument then played, it is impossible to get any fine tone out of it. The tone is, indeed, thin and offensive. Indeed, every kind of musical instrument is provided with some device or other in order to reinforce the sound which it produces. Such devices are known as resonators, and they are of extreme importance in music of all kinds, including vocal music. The manner in which a resonator acts is by increasing the amount of air which is thrown into vibration.

Science of Resonators. When, for instance, the stem of the sounded tuning-fork is placed upon a table, the table itself vibrates at the same rate as the fork; and consequently a very much larger amount of air is set in motion. The rule with resonators is that there are certain tones which they best reinforce. A series of resonators can be made, indeed, such that each responds to a given note and to that alone; or, at any rate, if to other notes, only to those of very nearly the same pitch. The selective action of resonators can readily be shown by holding a sounding tuning-fork over a tall cylindrical vessel containing

water. The sound is found to be greatly reinforced only when the water in the tube stands at a certain level. This experiment furnishes the proof of a most important fact. Let us suppose that a compound tone is being sounded. The proportion and relative value of its over-tones can be almost indefinitely modified by the use of various resonators which pick out and reinforce various over-tones or combinations of over-tones. The immense musical importance of adapting one's resonators so as to reinforce certain selected over-tones will be discussed later.

Harmonics of the String. Let us now return to our stretched string, or monochord. So far it has merely taught us that its note varies according to the length of it that is allowed to vibrate. Now, if, instead of merely plucking the string with the finger, we throw it into what is called forced vibration by means of a violin bow, we discover that more harmonics are produced. Only the very highly trained ear can actually detect them; but everyone is able at least to recognise that a much finer and richer tone is produced by bowing the string than by plucking it. The difference is not a question of loudness, and the note is the same in both cases; it plainly depends upon the presence of over-tones. It is, indeed, found that the string is vibrating not only as a whole, thus producing its fundamental tone, but also in two equal halves, thus producing an upper partial, or over-tone, an octave higher, and also in other proportions, corresponding to the interval which is called the twelfth, to the double octave, and so on.

It is the presence of all these additional tones, happily blended with the fundamental tone, that accounts for the superior quality of the sound now produced. Each of the strings of a fine piano acts in precisely the same way, and there is a simple and interesting fashion in which this can be proved. Hold down with the fingers a series of notes on the piano, such as C in the bass clef, the C above that, and also the E, G, and B flat above it; now strike very firmly the low C below the bass clef, and let the note go. Immediately you hear, if the piano be a good instrument and in tune, a soft chord consisting of the notes which you are holding down. (The reason why one has to hold them down is to prevent their vibrations from being damped, as they would otherwise be.) The explanation is very simple. The low tone which was struck contained a number of upper partials; the string was vibrating not only as a whole, but also in segments corresponding to the various over-tones. How do we know this? The only statement that needs to be made for the complete understanding of the experiment is a statement of the fact which is called *sympathetic vibration*, at which we have already hinted in describing the selective action of resonators.

Sympathetic Vibration. The upper strings in our experiment, being left free to vibrate by having their dampers removed, have responded each to the over-tone identical with its own fundamental tone, in just the same fashion as a resonator of a given size and shape responds to a given over-tone in a clang or compound note. The occurrence of sympathetic vibration is not difficult to understand. We must imagine that the case is not dissimilar to the pushing of a child on a swing; a series of taps given at the right moment will soon produce a very decided vibration. In the case of the very best pianos, sympathetic vibration is a very large factor in explaining the quality of their tone, since, whenever the loud pedal is down, all the higher strings that correspond to the over-tones of any lower note that may be sounding are thrown into vibration. For this purpose it is necessary that the piano be perfectly in tune, and the owner of a fine piano but only a moderately fine ear, may know that his instrument needs tuning, less because any defect can be definitely observed than because its tone appears to be rather less rich and resonant than he has observed it to be immediately after tuning.

Nodes. If we take the simplest case of an over-tone, the production of a note an octave above the fundamental tone, we may imagine—and, indeed, may see—the string to be vibrating in a fashion which is represented by the accompanying diagram. At the point A we have what is called a *node*; the segments of string on each side of it are vibrating in opposite directions, and are technically known as ventral segments.

This is the simplest case but one, the simplest case obviously being that in which the string has but one ventral segment, while its fixed extremities constitute its only nodes. But, indeed, a musical string is susceptible of an infinite variety of modes of vibration corresponding to different numbers of subdivisions into ventral segments. It is the general rule that the over-tones tend to become fainter as one passes upwards. The higher the over-tone the larger is the number of ventral segments of the string, and the less is the amplitude of their vibrations.

A second figure indicates the state of affairs when a string is giving forth both its fundamental and its first over-tone. It is, of course, evident that no part of the string can be in two places at the same time, as the diagram would at first sight appear to indicate. But, in reality, the motion of the string in such a case is complex, being the resultant of two factors, one corresponding to the fundamental and the other to the over-tone.

The diagram expresses in merely ideal fashion the shape of the vibration that corresponds to each of these. The extreme complexity of the motion of the string when the number of over-tones is very large may easily be imagined.

Tuning of Resonators. Helmholtz made many interesting experiments with resonators, and devised a large instrument consisting of a whole series of resonators arranged in a definite order. Any one of such tuned resonators may be used in order to demonstrate, even to an unmusical ear, the corresponding over-tone in a compound note. Each of them is a hollow sphere, with two opposite openings, the smaller of which is applied to the ear. If now the compound tone be sounded, the resonator will immediately demonstrate the occurrence of its corresponding over-tone by greatly reinforcing it. These resonators may be arranged in such a position as to affect flames placed opposite them. When one sings opposite such an arrangement, the movement of the flames (which may be readily made visible by means of revolving mirrors) tells one precisely which over-tones are contained in the note one is singing.

Vibrating Plates. What is true of strings is true of other vibrating bodies, such as plates. The physicist Chladni made a study of this subject by taking square plates, clamping them in the centre, and sprinkling very fine sand upon them. If now the edge of such a plate be bowed, it will vibrate in a particular fashion; and this will vary if the finger be placed upon the plate at various points and accordingly as the position of the bow is altered. The plate has its nodes just as the string has, their position varying with these varying circumstances, and the sand naturally tends to be thrown upon whatever may happen to be the nodes or nodal lines of the plate. Hence there may be produced an endless number of sand patterns, which are everywhere known as Chladni's figures.

Pipes. The principles we have already learnt are applicable not only to stringed instruments but also to wind instruments, such as an organ-pipe or a flute. The column of air in such an instrument is of a certain length, and is capable of vibrating at a certain speed. That we already saw in the case of the column of air above the level of the water in the cylindrical glass vessel which we used when studying the principles of resonators. The differences between various types of wind instruments are extremely interesting, especially to the musician, mainly because each of these types has its own characteristic capacity for the production of over-tones. For instance, what is called a stopped organ-pipe is capable of giving only the odd over-tones—those whose frequencies are three or five times, for instance, that of the fundamental tone. Obviously, the quality of a note produced by such a stopped pipe must be quite different from that given by the open pipe, which is able to yield the complete series of over-tones.

The Human Voice. But the only kind of musical instrument which we have space to discuss here is the human voice—the oldest and most interesting of all. Essentially it is produced in the voice-box, or *larynx*, which is developmentally equivalent to one of the gill arches of the fish. The various cartilages of which it consists are all devoted to the service of the *vocal cords*, which are made of fine elastic tissue, and are practically stretched strings. In front they are attached close together, quite close to the projection which we call Adam's apple. Passing backwards, they slightly diverge; but the larynx is so constructed that they can be quite closely apposed, so that only a tiny chink is left between them. This the singer or speaker does, and then, by means of a forced expiration, drives a column of air against the resisting cords, which are thereby thrown into vibration. The rate of the vibration or the pitch of the note produced must depend, our study of stretched strings has already shown, upon the tension, length, and mass of the cords.

A man's larynx is larger than a woman's; his cords are longer and heavier, and therefore his voice is of lower pitch.

Causes of a Good Voice. The only factor over which we have control is the tension of the cords. If a dissected larynx be caused to emit a note, it is found to be very thin and unpleasant, being what teachers of singing call the "naked tone." But in the case of even the finest singer, no tone is actually *produced* anywhere save in the vocal cords. All the over-tones which make his voice so beautiful are produced by the partial vibration of his vocal cords. What enables him to produce such fine tone is his possession of resonators which are either naturally fitted to reinforce the most desirable over-tones, or else are capable of modification at his will for this purpose.

Voices undoubtedly differ from one another naturally in respect of their quality, the shape of the unchangeable resonators being—in some people—fortunately precisely adapted for purposes of singing; but, in addition, voices vary widely because of the varying skill with which the modifiable resonators are employed. We all of us have skill enough to modify our resonators so as to produce the various vowel tones, and the singer's skill is only an advance upon this.

The Man of Many Voices. When the teacher tells the pupil how to "place" the voice, what is meant is simply that the muscles of the tongue, lips, and throat are to be so co-ordinated that the best possible resonance is ensured, picking out and reinforcing to the utmost the most valuable of the over-tones in the laryngeal note. But there is a much higher art than this, and one known to only few singers—the art of modifying the vocal colour or quality for various purposes. Plainly, different qualities of voice are required for imprecation, love-making, and defiance. The most accomplished of living singers, M. Victor Maurel, is really the possessor of half a dozen voices. His art consists in his amazing control of all his modifiable resonators, so that while sounding one and the same laryngeal note, he is able, by variously selecting and reinforcing its various over-tones, to endow it at one time with a sensuous, at another time with a martial, at another time with a devotional quality, and so on. Why various clang-tints should possess such varying significance is not for the physicist to say.

Continued

WORKSHOP PRACTICE

The Scope of Engineering. Its Theory and Practice. The Several Departments. Castings, Patterns, and Cores

Continued from page 2022

By JOSEPH G. HORNER

THERE are few, if any, of the professions or manufactures which are so many-sided or so exacting in their technical demands as mechanical engineering. The practice of it involves so much of science and theory, handicraft and machine operation, of general knowledge so wide, and specialisation so minute, that a successful engineer must never cease to be a student and a worker too. The early years of training are in but a slight degree preparatory to the work that comes after, the bare foundation on which the superstructure of life's long practice is reared.

The Vastness of the Scope. The work of the engineer is in evidence all the world over. He designs and builds the tireless engines that run 200 miles without a stop, or which propel the big liners with the power of 30,000 horses, or drive the machines of our mammoth factories. Machines numbering thousands of distinct types, beautiful machines of marvellous precision employed in a hundred separate industries, are turned out of the engineering workshops of Europe and America in countless numbers. The bridging of the estuary of the Forth, of the Thames by the Tower, of the Zambesi, of the Hudson River at New York, of the broad rivers of India, Australia, and the United States, is the work of the engineer's hand. So, at the other extreme, is the making of the typewriters, the cash registers, the sewing-machines, and the small arms; and the systems and methods by which these mechanisms are produced in vast numbers are fully as marvellous and fascinating as are those by which vastly more imposing engines, machinery, and structures are built up. The principles and methods which underlie them all are similar, only differently applied. So, too, the materials used are identical; and thus it is that all engineering practice, no matter how diverse, is linked by common features, so that the man of broad technical training can, if necessary, soon acquire precise knowledge in any of the great departments between which it is specialised.

Let us see now in brief what is involved in the study of materials, designs, and methods employed in the practice of mechanical engineering.

Materials of the Engineer. There are not many materials, natural or artificial, which the engineer does not in some way or another press into the service of man. But the principal ones are the metals and alloys, timbers, and concretes. The metals take first place, and these are chiefly iron and its alloys, copper, and the alloys which it forms with tin and other metals. Superficially the objection may be made that this is metallurgy, and not engineering. But the engineer must make himself familiar with the physical characteristics and behaviour of the common metals and alloys if he is to avoid committing blunders in design. The failure of structures and mechanisms is the heavy price which has often been exacted as the penalty of ignorance, or neglect of these matters. Neither can the question of the absolute strength of these materials be considered alone, but the engineer must become familiar with the many faults which they are liable to develop during the course of manufacture, and the knowledge can be gathered only by much experience in practical duties. Their endurance or weakness under different conditions of stress, strain, and fatigue; under the action of heat, cold, moisture, or dryness, climatic or otherwise; their greater or less adaptability to various kinds of service have to be understood. An engineer, in short, must possess as intimate an acquaintance with all the materials he has to use in their numerous grades, weaknesses, and faults, as the agriculturist with his soils, or the doctor with anatomy, or the naturalist with his microscope.

The Disposition of Materials. Yet this is but the beginning of knowledge, for when we have our wealth of materials suitably selected, we must be able to dispose of or arrange them in both the strongest and cheapest manner. For these materials are all costly, and therefore it becomes of the first importance to economise them to the utmost. This necessity explains broadly the reasons for the outlines given to most structures and framings; the iron, steel, or alloy being arranged in the particular fashion which affords the maximum of strength with the minimum of material. Included in this general problem is the direction or disposition of material which corresponds best with the direction and intensity of stresses. Cast iron, for instance, should not be subjected to tensile stresses; while wrought iron and mild steel appear to best advantage in such cases.

And here, in the work of design, a vast amount is comprehended. It involves a working knowledge both of statics and dynamics—of bodies at rest, and of those in motion. It is most essential, too, to distinguish between dead and live loads; or in other words quiescent loads and those which are constantly changing in nature and intensity, since the latter are far more destructive to mechanisms than the former. The strength of bodies in movement introduces and involves problems of gravity, of centrifugal force, cohesion, and the effects of angular movements. Other results also follow, besides that of dynamic strength, the greatest of

which is friction. If there were no friction a machine would give out as much power as it received. In an average factory about half the power delivered is used up and lost in the belting and shaft bearings before any useful work is done. Friction occurs in all slides and spindle bearings.

Ingenuity of Modern Mechanisms. Few save engineers know the hundreds of devices embodied in modern mechanisms having for their sole object the reduction of friction. Some of the best engines have their working parts wholly encased in an oil reservoir, the supply of which lasts for several months. All large engines have their moving parts lubricated automatically from cisterns, shaft bearings have many devices to facilitate the distribution of oil, many are lined with alloys of white metal which reduce friction. Further, the proportions of bearing surface are constantly being increased to lessen the pressure per unit area. By these and kindred devices the durability of moving parts is greatly prolonged.

The true engineer must also possess a working knowledge of many sciences besides those which deal with the mechanical aspects of things. An intimate acquaintance with the laws and effects of atmospheric pressure, of heat, electricity, and hydraulics is of first importance. These face him at every turn—in steam and gas engines, in steam boilers, in the electric driving of machines of most kinds, in water turbines, in pumps, and in the flow of liquids. Inorganic chemistry cannot be neglected, for it plays a vital part in steam boiler troubles, in refrigerating plants, in the reduction of the metals, and in the preparation of alloys. Organic chemistry is touched by the composition and action of the oils and fats used for lubrication. Practical geology is an aid to men who sink artesian wells, or who have to do with the equipment of mines and quarries. Mathematics, geometry, and the art of rapid sketching and drawing are all essentials to the equipment of a perfect engineer.

Theory and Practice. Yet these are but the preparatory stages in the training, only leading up to the construction of those mechanisms which are the actual embodiments of the ideals. It is here that many men are found wanting. They have theory and science at their fingers' ends, but have never made anything or taken a part in the manufacture of a mechanism, have never acquired those lessons of experience which are of enduring value in the world's work. To learn these they must "go through the shops," must work in the departments of an engineer's factory, must handle tools and machines, and assist in the building-up of machinery stage by stage.

Many Trades in One. A most interesting feature about an engineering works is that though it comprises an assemblage of various kinds of shops, it forms an organic whole. From one point of view each department seems to stand alone, yet each is actually dependent upon all the rest, and the work of the management consists largely in keeping things moving between departments in order to secure the economical production of the final mechanisms. The foundry must not be short of patterns, nor the turnery and the machine-shop be kept idly waiting for castings and forgings. Every element in a machine, whether it be a massive casting or forging, or a little bolt, has to pass through more than one set of hands in its progress to the mechanism in which it finds a home. If error is made in one shop it entails inevitable trouble in another, and therefore engineering practice differs in these respects from some other trades where a piece of work is began and finished in one shop only. This practice in a typical works involves the following departments of activity.

Design and Drawing. In a well-conducted works, no piece of mechanism is made until its design and dimensions, with all particulars as to materials and methods of construction, have been definitely settled and embodied in suitable drawings for use in the shops. The men who do this work must combine a knowledge of theory with that of practice, for if they are deficient in the latter their design will prove either unworkable or unnecessarily expensive, an evil which does arise not infrequently. This subject is treated in Drawing for Engineers.

The Pattern Shop. The pattern shop and foundry are two distinct departments, in which the methods and materials have not the least resemblance to each other; yet they are the two most intimately related shops of any in the works. The first-named would be taken by a casual visitor for a carpenter's shop; the engineers' carpenters and pattern-makers, in fact, often work together. But beyond the feature which both trades have in common, of working in wood, there is no resemblance. The fact that the pattern has to be used in the formation of a mould for casting into renders its construction essentially different from that of a mere piece of woodwork. A carpenter could not make a pattern, simply because he does not know the methods of moulding, knowledge which the pattern-maker has to possess in addition to the technique of the carpenter.

The Foundry. The work done in the foundry is the making of moulds, and casting, or founding, of metal into the impressions produced by the patterns. But *the foundry* is an extremely comprehensive term, including numerous divisions carried on by different men in different buildings. Iron, brass, and steel castings are always kept entirely separate; so, generally, is aluminium. And within each of these are many subdivisions under the charge of specialists, as green sand moulding, work in loam, core making; or, again, hand work and machine work, with others yet more minute, in which one class and size of casting only is done, year in, year out, as engine cylinders, pumps, railway chairs, brake blocks, and so on.

The Smithy. In the smithy, forged work alone is produced, but here also by different methods, as at the anvil alone by hand, or under power hammers, operated either by steam, belting, water, or compressed air. These correspond with two great subdivisions, that of the

anvil smith, and the stamper; the first named a craftsman, the second very often a comparatively unskilled man, who nevertheless may turn out twenty, forty, fifty times more products than the skilled smith working by handicraft alone.

The Boiler Shop. The boiler-making shop and the plating departments are two great and important shops, which, though generally kept distinct, have much in common, since they both use plates of steel and iron, and rolled sections of the same materials, in the form of angles, channels, tees, etc.; and they both adopt similar methods of union—that of rivets and of welds. In some respects, too, their methods resemble those of the smithy, but the crafts are always kept distinct, and carried on by different sets of men.

In none of these departments would the casual observer see much that he would recognise as engineering, save, perhaps, the manufacture of steam-boilers. And these are, in fact, the preparatory shops only, whence the rough-cast and forged work is supplied to the engineers' turners and machinists, who take it in hand and remove the rough exterior with cutting tools of various kinds, so that the fitters and assemblers may receive it in suitable forms and of correct dimensions to be built up into mechanisms. To many these last departments stand as the visible embodiment of engineering. Many factories have no other departments than these, adopting the policy of ordering their castings and forged work out. These shops have, as regards their methods of operation, little in common with those we have noted. Machine tools, more or less massive, predominate; there is little hand work done, and that little lessens constantly in volume, invaded more and more by machines. These turn, plane, shape, mill and grind the metal smoothly to very precise dimensions, generally within a thousandth part of an inch, or less in fine work. The operations done here, marvellous to the lay mind, are not less marvellous to those who live and move among them and conduct the shops. In no department have such great advances been made in recent years as in these, whether regarded from the point of view of gross output, of fine precision, or of beauty of mechanism—much of which, also, is automatic work.

Erecting and Assembling Shops. In the erecting and assembling shops the prepared units are built up into the complete machine. The difference between them is that in the erecting shops much hand work is done, none in the other. This, as we shall see, is a very important distinction in the economy of production.

These do not exhaust the departments which are found in large representative engineering works. Coppersmiths' and tinmen's work are present in many—as in locomotive and marine shops, in pump makers' and brewers' engineering establishments. Heavy carpentry is done in crane shops, in locomotive shops, and in those who do work for civil engineers. Many engineering firms now make their own electrical apparatus for motor driving and for lighting, and there is then a wiring department. Painting and polishing shops, too, are often a part of the equipment of a big factory.

An important section sometimes is the testing department, which may include testing of raw materials as well as of finished products. Every motor, machine, and mechanism made to specifications must be subjected to tests of some kind, and the nature of these, of course, varies much with the character of the work—that for a steam boiler, for example, being necessarily of a very different kind from that of a machine or a bridge.

We have taken a very concise survey of the ground which will be covered in detail in this series. The vastness of the field must be our justification for brevity and for statements of principles and cardinal practice without exhaustive detail.

To those who desire to become engineers, the vast extent of the knowledge which has to be acquired may seem staggering. But plodding industry will accomplish much.

The Fascination of Work. Yet there is no alternative to incessant work. Even the conscientious worker may not succeed, but the idler must fail. The true engineer finds his recreation in his work. There is a fascination in it which increases with years. In its many-sidedness lies much of its charm, and the broad-minded man of wide experience sees more than he who specialises round one branch. He feels something akin to the thrill of romance when contemplating a structure like the Forth Bridge, or the Tower Bridge, the stately movements of massive engines, the tireless movements of a machine tool, the forging of a white-hot mass under hammer or press, the roar of a Bessemer converter, or the towering blast furnace.

Custom cannot stale the infinite variety of engineering practice. It looms larger in the great world as the years roll on and the continents become opened to civilisation. But though its practice ever varies, the principles on which it all is built remain eternal and unchanged.

CASTINGS & THEIR PATTERNS

It is intended in this section to consider the work of the pattern-maker and moulder together instead of approaching them as isolated trades. The pattern is regarded from the point of view of its mould, as the means by which the casting is obtained, for the pattern is temporary, the casting permanent; only in this way can correct views be gathered.

Those who are familiar only with work done in stone, timber, and solid materials, will imagine the art of moulding and founding in sand to be one of the most curious in existence. But for the fact that it is so dirty and grimy a trade, it would take a much higher rank in popular estimation than it does. We do not forget that many of the early mediæval founders were also great designers, architects, painters, sculptors, and that they idolised and idealised the art of the moulder and caster in bronze.

If we except the very small proportion of moulds made in plaster and in metal (chilled moulds), all founders' work is prepared in sand—loose, powdery, friable—the poorest material, apparently, to withstand the inrush of molten metal, the high specific gravity of which is only disguised by its molten, fluid condition; for liquid iron is seven times heavier than water. And yet this sand will endure either the invasion of tons upon tons of molten iron or steel, or the few pounds of brass melted in a crucible. It is in the preparation, manipulation, and support afforded to the sand that the secret lies.

Moulding Material. Little difficulty need be experienced in understanding why the founder must employ this material in preparing his moulds. Think of almost any substance but sand, and the necessary conditions will be absent. The material must be obviously non-inflammable, which condition excludes wood or wax. It must be capable of being moulded into a thousand diverse forms, which excludes rigid metals—except for chill moulding, to be noticed presently. It must be very porous, to permit of the escape of gases generated during casting. It must cohere firmly, and not be acted on chemically by molten metal in such a way that the essential properties just noted should be changed. Lastly, it must be very abundant in nature, and cheap. Sand is the only substance which fulfils the whole of these conditions, which explains why all moulding and casting, with some very slight exceptions, is done in this substance.

The Moulding-box. But, though there is considerable coherence in sand when moistened with water, that alone is not sufficient to sustain the materials in moulds without extraneous aids. Hence we have the moulding-boxes, or flasks, within which the sand is rammed, and retained during making and casting. The differences in these boxes will be illustrated in another part of this course. Nor is the support of the boxes alone sufficient in all cases, since in most moulds there are many very weak sections or tongues of sand that are neither self-sustaining nor strong enough to withstand the rush and pressure of metal. Such weak portions have to be stiffened by the adventitious aids of "lifters" or "gaggers," rods, and nails—the internal skeletons, as the moulding-boxes fulfil the function of external skeletons.

When we go a stage further, and attempt to construct actual moulds, the discovery is soon made that all sands are not alike, and that there are certain properties that must be possessed by different sands, and mixtures of the same, for different classes of work, which are designated by various terms that denote their characteristics. Highly siliceous, heat-resisting sands occur in many districts, and to these are added coal dust, or, in some cases, horse manure, as follows.

Moulders designate sand as *strong* or *weak*, terms which distinguish respectively the material of greater from that of lesser consistence. Within these extremes there are numerous grades of each. Horse manure enters into the composition of all strong sands, ill-digested hay affording a good binding material, which also, when burnt out by the heat of the molten metal, assists in the *venting* of the sand. Strong, close, heavy, clayey sand has the disadvantage of being less porous than the weaker sands, and therefore it requires more venting, both with the vent wire and horse manure, than the other.

At these extremes the components of sand mixtures are composed of clayey sands, and of fine sharp sands. The first are often of a yellow colour, the second red.

A Practical Test. A practical test of the difference in quality is to squeeze a handful. If it retain the shape imparted, it is suitable for general moulding; if too heavy, and decidedly clayey, it should have a finer sand mixed with it; if it fall to pieces on the removal of the fingers, it is too *open*, and needs to have a stiffer clayey sand mixed with it.

Actually in foundries only a small proportion of new sand is used in moulds, the old or "black sand" on the floor forming the largest body of the mould, or *box filling*, and the new sand being mixed for *facing* the moulds only, to a thickness varying from an inch to two or three inches. The stronger the sand is required, the less old sand can be used for intermixing.

Strong clayey sand requires another ingredient—coal dust—in large proportions, to counteract its closeness of texture and render it better able to permit of the discharge of the gases generated by casting. This has the effect of rendering the mould more open, because, being burnt out at the time of casting, it leaves the sand to that extent porous.

The stronger sands are used in those classes of work where the mould is subject to great pressure of metal, and to prolonged heat; the weaker for the light casts, where there is little pressure and little mass, so that cooling takes place quickly.

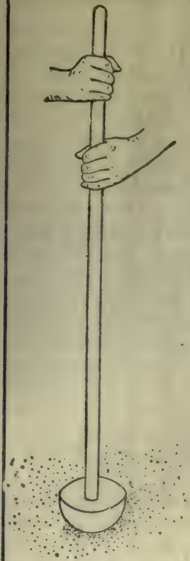
Kinds of Sand. The difference between *green sand* and *dried sand* corresponds to a certain extent with the *weak* and *strong* sands respectively. But many green-sand moulds are made in strong sand, though no dried moulds can be made with weak sand. "Green sand" denotes any mixture, weak or strong, that is *not dried*; "dried sand" is a particular mixture of strong sand, containing old and new sand, horse manure, ground loam, and moistened with clay water.

Cores are the internal parts of moulds. They are made of various kinds of sands, similarly to moulds, ranging thus from fine red or yellow sands to mixtures of dried sands, loam, and horse manure, with other sands. But *core sand* denotes a strong sand, which has to be dried.

Whether sands are weak or strong, green or dried, it is essential that they shall be able to resist the pressure of metal without distortion or fracture, and that they shall offer no obstacle to the escape of the gas generated by casting. We now propose to discuss the method of ramming and supporting the sand.

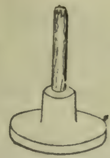
But first a reference is necessary to the other materials of moulds just mentioned. These, a very small class, may be briefly disposed of.

Plaster of Paris is used for a few small moulds

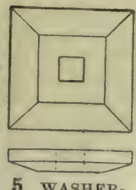


1. RAMMING

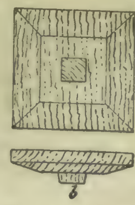
2. PEGGING RAMMER



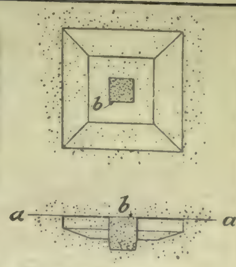
3. FLAT RAMMER



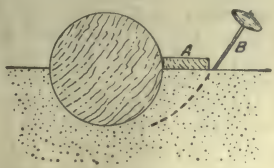
5. WASHER-PLATE CASTING



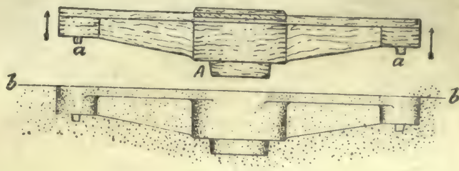
6. PATTERN FOR NO. 5



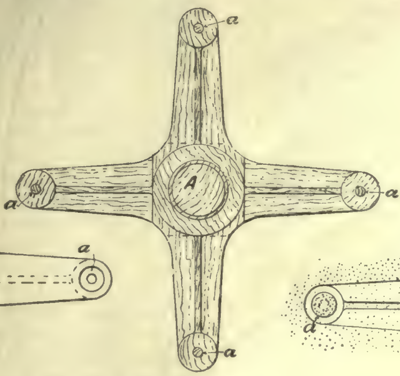
7. MOULD FOR NO. 5



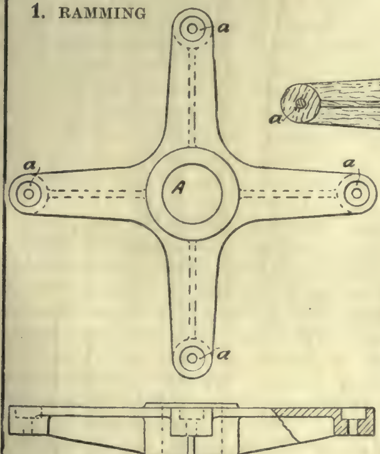
4. VENTING



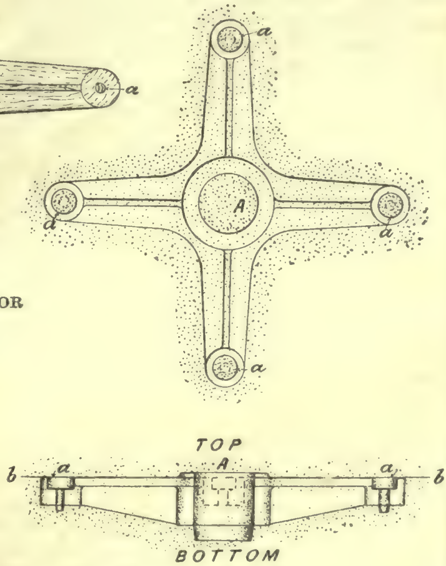
10. WITHDRAWING PATTERN FROM MOULD



9. PATTERN FOR NO. 8

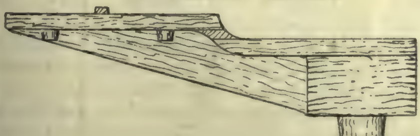


8. BASE-PLATE CASTING

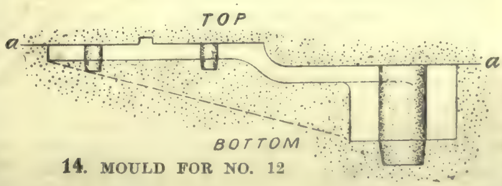


11. MOULD FOR NO. 8

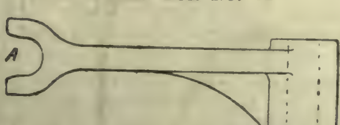
12. BRACKET CASTING



13. PATTERN FOR NO. 12



14. MOULD FOR NO. 12



15. TUMBLER CASTING

16. PATTERN FOR NO. 15

ILLUSTRATIONS OF PATTERNS AND MOULDS

in the jewellery trades, and occasionally for small brass work. Its advantage is that several casts can be made from one matrix. But it is limited to such cases, and has no place in the general engineer's foundry.

Chill, or chilled moulds are used in cases where special hardness is required on the surface only of a casting, all the casting body remaining soft. Its utilities are confined to a few articles, such as some trolley wheels, chilled on the "tread," or periphery; rolls for working on iron and steel plates; ploughshares hardened at the points and on one face; some machine slides; and the bores of some axle boxes. The *chilling* is accomplished by pouring the metal against a cold iron "chill," which produces a steely face. Excepting on the face thus chilled, all the remainder is ordinary metal cast in sand.

Ramming. We come to the methods of *ramming*. In all moulds, except some which are very shallow, ramming is essential to the proper consolidation of the sand around the patterns. These exceptions occur chiefly in such work as making foundry lifters or gaggers, some rough and shallow kinds of fire-bars, etc. But in all ordinary work, whether deep or shallow, the sand must be rammed around the pattern.

Another fact is that no mould can be produced which will fulfil the conditions just named unless the whole of the sand is thus rammed in detail. It is not sufficient to throw in the whole boxful of sand, trample it down, flat-ram, and strickle it off. Bit by bit every inch of the sand must be consolidated with the rammers, and the nearer to the pattern it lies, and the more slender its projecting portions, the greater must be the care exercised in ramming it. All ramming must begin in corners, around flanges, bosses, prints, before the main body of the sand is filled in. The flat rammer is not used in doing this work, but the "pegging" rammers, two forms of which are shown in **1** and **2**, or else—as is often the case in very small moulds—a bit of round rod $\frac{3}{8}$in. or $\frac{1}{2}$in. diameter, is employed to press home the sand. Only as much sand is thrown in as can be rammed properly. It may be a handful only, or a few shovelfuls, depending on the mould.

The Force of Ramming. Little by little the sand which lies immediately next the pattern is rammed thus in detail, using facing sand first, taking care not to bruise the pattern by allowing the rammer to come in contact with it. As the work proceeds, the facing is backed up by the old sand from the floor for box filling. This is also rammed in detail, but so much care is not necessary here as in working the facing sand. It has simply to afford backing, or support, to the sand that is next the pattern. In very small moulds no such distinction need be made, but one kind of sand would be used throughout.

When the box part is filled up to a height of, say, an inch above the joint face, the flat rammer [**3**] is employed to finish the whole to an equal consistence on the top, and the strickle and trowel level the joint face.

The force which is put into the ramming varies. Taking extremes, light, soft ramming results in castings covered with lumps, the imperfectly rammed sand yielding locally to the pressure of the metal. On the other hand, heavy, hard ramming is productive of "scabbing," the sand flaking off owing to the bubbling of the metal against a surface too hard to permit of the complete escape of gases. But these results can be and are modified by the nature of the sand mixture used, by the extent of the venting done, and by the location of the rammed part. Thus, a well-dried mould will endure without risk hard ramming that could not be put into a damp mould. And the more moisture there is in a mould, the more risk is there of swelling, or scabbing, occurring through light or hard ramming respectively. This is the reason why many green sand masses are "skin-dried" only on the outside. Again, much harder ramming can be done if the vent wire is freely used than if it is sparingly employed.

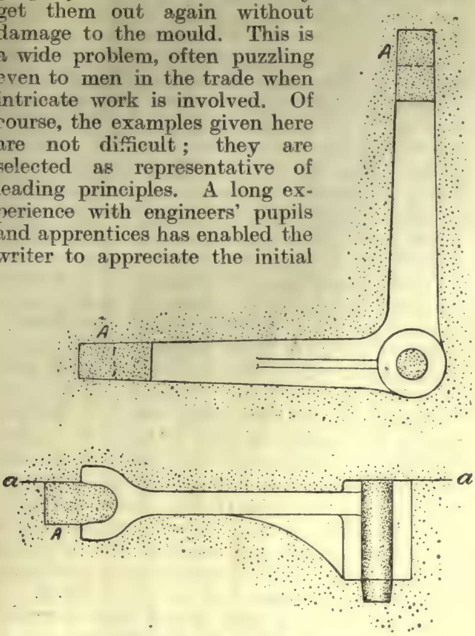
The location of the rammed part is of great importance in determining the degree of hardness or softness of the ramming. The bottom and the top of a mould are those which are subject to greatest pressure and most liable to scab. These should be rammed harder than the sides, and vented most. Frequently, in fact, a stronger sand is used for the top than for the sides. Sometimes the top is dried, while the sides are green. Sometimes loam cake is rammed in those portions of the bottom of a deep mould against which the metal beats or falls during the pouring.

Venting. The term *venting* signifies piercing the sand, during intervals of ramming, with innumerable fine holes, produced by a vent wire [**4**], ranging from one-sixteenth to a quarter of an inch in diameter. Through these vent-holes the gases escape at the time of casting and immediately following thereon. The vents, therefore, act as safety valves to moulds which would otherwise become blown up, broken, and damaged, which happens in some degree when the venting is insufficient. *A*, in **4**, is a strip of wood held down on the mould joint to prevent the sand from becoming pulled up on the withdrawal of the vent wire, *B*.

Many sections of the sand require support, as previously mentioned, other than that due to the consistency of the moistened and rammed material. Nails, rods, and lifters are the means employed. It is not enough to lay these in the mould; they must have something to take hold of or be supported on—as lifters hung from the bars of boxes, and rods and nails which overhang, receiving their support in the main body of the sand. Such adjuncts are carried in any direction where they are wanted in moulds, and being dipped in clay water, the sand sticks around them, and is held in place. These will be illustrated in another section, dealing with the divisions of the moulder's work.

Difficulties. Having thus dealt with the general methods of ramming, we must now regard the subject from another point of view. Various castings and patterns are shown in the illustrations which are given in this section,

with the methods of dealing with them in order to obtain moulds of the same shapes. Obviously, though it is easy to enclose the patterns in sand, properly rammed, it is necessary to know how to get them out again without damage to the mould. This is a wide problem, often puzzling even to men in the trade when intricate work is involved. Of course, the examples given here are not difficult; they are selected as representative of leading principles. A long experience with engineers' pupils and apprentices has enabled the writer to appreciate the initial



17. MOULD FOR NO. 15

difficulties experienced by these, in regard to methods of producing the different forms of moulds required for the infinite varieties of castings made. These difficulties are of a different character from those which exist in the work of the machine shop, or smithy, or boiler shop. They involve the productions of forms which exist first only on drawings, more or less intricate, and which have to be made by methods that often permit of several alternatives; all practical perhaps, but not all economical, or mechanically desirable.

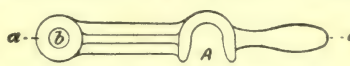
Often the pupil or apprentice will see that very slight, and apparently unimportant variations in form involve a different method of making, that different men will arrive at the same result by the adoption of dissimilar methods, that there are often great differences made, if a few only, or if large numbers of castings are required; and sometimes it happens that after a pattern has been made to mould in one particular way, the moulder will get it altered to mould in another. All these are puzzles to the beginner, and they serve to encircle the foundry craft with an air of mystery, for which there is no real objective. It is not so difficult when a man has grasped the principles thoroughly, and had some experience, to settle a suitable method of making any mould whatever, even though he has never seen anything precisely like it before.

Some Problems and Answers. Beyond the fact that the function of patterns and cores is to form impressions into which metal has to be poured, the mind of the pupil assumes a state of chaos. What determines, for instance, the relations of a pattern to the top and bottom portions of a mould? Why are cores inserted in some cases and not in others? Why are some portions cored out, and others left to deliver themselves from the pattern? Why are some pieces affixed loosely? These questions will find solution in the illustrations which follow in this course.

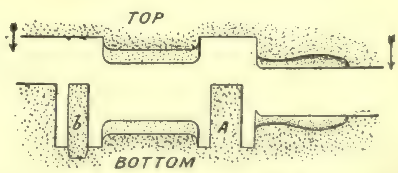
Fig. **5** is the simplest thing possible, a plain washer plate. Its pattern is seen in **6**. This is moulded with the flat face uppermost, in a plane with the joint *a-a* of the top and bottom boxes [**7**]. The reason is that if moulded with the bevelled edges uppermost the moulder's sand joint would occupy more time in making. The hole is formed with a separate dried core, *b*, inserted in the impression made by the print *b* in **6**, because it is easier to core cleanly than to allow the hole to deliver from a hole in the pattern. But, if so delivered, which is often done, about one-eighth of an inch of "taper" would have to be imparted to the sides, and then the hole could not be cast parallel. The upper part of **7** shows how the opened mould appears in plan, with the core inserted, ready to be covered with the top box of the mould.

Crane Base. Fig. **8** gives views of a baseplate for a wharf crane. In plan it has the shape of a cross. It is moulded with the vertical ribbing downwards, because less damage is inflicted on a mould by withdrawing the pattern out of the sand than there would be if, the ribs being uppermost, the sand were pulled up away from them. This is a very important practical detail, and it explains why, when deep ribs must for various reasons come sometimes in the top, they are left loosely attached to the pattern. Then they remain embedded in the sand of the top box, while the latter is being lifted, and when it has been turned over, the ribs are pulled out just as they would be from the bottom portion of a mould.

The holes *A*, for the central post, and for the foundation bolts, *a a a a* [**8**], are cored, for



18. PAWL CASTING



19. MOULD FOR NO. 18

self-delivery would be impracticable. Fig. **9** shows the pattern in plan, looking on the ribbed face, with the core prints lettered similarly to the holes in **8**. Fig. **10** is a cross section through the pattern just delivered from its mould below, and **11**, upper Fig., is the open mould—*i.e.*, not covered with its top box, the jointing of which is in the plane *b-b*, **11**, lower Fig.; and both showing the cores in place, lettered similarly to the holes and core prints in the figures preceding.

The bracket casting shown in side view [12] is moulded with the rib lowermost for the reason just given, and the sand joint *a-a* between top and bottom box follows the top face of the pattern. The holes for the shaft and those for the bolts are cored. There are two alternatives, either of which would be adopted by different men. In one the bracket would mould as it lies in the drawing, the rib lying horizontally, in the other the rib would come in the top box. Either would give rather more trouble than the method we illustrate. Fig. **13** shows the pattern construction, with its prints; **14** a section through the cored-up mould.

Prints and Cores. The tumbler bracket [**15**] must mould with its two arms [compare with **17**] in the same horizontal plane, and properly with the deeper boss lowermost as shown, for the reasons just now mentioned in speaking of ribs. There is then no chance for the shaft-bearings, *A*, to deliver, and therefore they are cored out. The prints and cores are indicated in the pattern and mould [**16** and **17**] respectively. A point to note is that the print *A* is made sufficiently wide to afford support to the core, without the supplementary aids of chaplet nails. The joint between the top and bottom boxes runs along the edges *a-a*, which extend from the top of the print around the upper edges of the pattern absolutely.

The pawl [**18**], in which a similar shaft hole, *A*, occurs, is not cored, because it will deliver its own sand. And it is a matter of indifference whether it moulds with the joint at *a-a* [**18**] or quarter round in the plane of the paper. The irregular jointing between top and bottom necessary in each case is about equal in amount. The only difference made is that in one case the core for the fulcrum hole, *b*, is put in a round print impression, and in the other in the impression of "pocket" or "drop prints," to which we shall come presently. Generally this slight difference would result in a decision in favour of the former method, because the simpler of the two. Fig. **19** shows the mould made by the former method, with top and bottom separated ready for closing. It illustrates how the sand must follow those outlines of the pattern which will afford free delivery.

Points at Issue. The student who approaches this subject for the first time will do so in a spirit of questioning. The subject will be further elucidated in subsequent articles, but there are some fundamental points which may be disposed of briefly here.

First, with regard to the method of producing these moulds. The details of making them are not illustrated yet, but only the *relations* of the moulds to their patterns, and without reference to their frames, or moulding boxes. In speaking of ramming, we remarked the necessity of operating in detail. Now, you cannot do that properly underneath a pattern, with a flat area; as, say, **6**, or **9**, or **13**. Such patterns are therefore moulded by *turning over*, which is the first broad division in the moulder's work. That is, the face which is finally lowermost in the mould is at first uppermost, and is rammed thus directly, and afterwards turned over, when the actual upper face is rammed. And this helps to explain why the position of a casting in the mechanism of which it forms a part does not concern the moulder in the least. He simply regards it from the point of view of how best to ram and pour it. But when, as often happens, moulds of large dimensions have to be made without turning over, then the ramming is a tedious process, because the pattern has to be taken out from time to time to permit of getting at the sand beneath properly. Fig. **4** is an example of a pattern that would be more easily rammed underneath than **9** or **13**.

Joints and the Moulding. Further, we see that while the joints between the top and the bottom of the mould are sometimes plane, as in **7** and **11**, in others they have to follow non-plane outlines, as in **14**, **17**, **19**. It does not follow that the joints of the moulding boxes must be non-plane. They are only so in a few very special cases. The irregular sand joints are sleeked within boxes that have flat joints.

As the joints of the top and bottom moulds have to be separated before patterns can be withdrawn, a separation must be made in the sand of the top and bottom. This is done by strewing a thin layer of another kind of sand between, termed *parting sand*. This is sand which has been burnt, being red sand baked in the core stove, or the scrapings from castings. In each case no moisture is present, and so the sand does not stick to the rest with which it comes into contact, but parts the two mould sections.

The Use of Simple Core Prints. Looking at the functions of the very simple core prints shown, the question arises why would not holes cut in the patterns deliver from the sand as well as the exterior edges, say, of their bosses? It is a natural question, and the reason is apparent only on experience of the work of moulding. Take, say, the large boss core in **14**, and suppose a hole to be cut in the boss to deliver its own core. During the loosening of the pattern by "rapping," preparatory to delivery, that small cylinder of sand would become cracked, and on the lifting of the pattern would be torn to pieces. The sand without the boss does not tear up, because the rapping squeezes it back slightly into the good sand backing around it. It is therefore necessary to make an impression (print) for small holes, and insert hard, dried cores subsequently.

Continued

THE MYSTERY OF THE MIND

Mind and Energy. Consciousness. Working of the Nervous System. How Many Senses Have We? Co-operation of the Senses

Group 3
PSYCHOLOGY
2

Continued from page 2016

By Dr. C. W. SALEEBY

OUR studies have prepared us, in some measure at least, for a right consideration of the mind. Throughout the whole course on Physics we were constantly discussing a something called *energy*. We saw that it is an indestructible entity or mode of being or object which cannot be created but which can be transformed without ceasing. We saw that light and heat or radiant energy, electricity and magnetism, energy of motion, energy of chemical combination, and even matter itself, must all be regarded as various mutually convertible forms of this one something called *energy*.

In studying the facts of living matter, readers of the SELF-EDUCATOR have also learnt that the heat of the body, its various movements and activity, are derived from the energy contained in the food. They have learnt that the law of the conservation of energy, asserted by physicists of, let us say, a falling stone, knows no exception within the living body, whether of a plant, a lower animal, or a man. The more complete our study of the physical sciences, the more thoroughly we blend physics, chemistry, and biology into a consistent and coherent body of knowledge, the more strongly are we imbued with the conviction that energy is the one reality, uncreateable, indestructible.

Mind and Energy. Thus, when the student of Physics turns to the consideration of the *mind*, he is extremely apt to take it for granted that here is just another form of energy, a trifle more subtle, perhaps, than those forms he has been dealing with (though some of these are subtle enough), but nevertheless necessary to be identified with them in the last analysis. Some such view of mind is probably more widely held at the present day by thinking people than is any other view, and appears to be much more securely based than at any previous time. A very popular form of it states that the ultimate reality is motion: mind itself, of course, being thus a form of motion, or, to use other language, a form of kinetic energy. The law of the conservation and endless transformation of energy is now not only familiar to all who have any acquaintance whatever with the sciences, but it is established on a base so broad and sure that it can never be shaken. Hence, it is difficult to resist the temptation to assume lightly that mind also must be a form of energy. The assertion that mind is a form of matter is too obviously ludicrous to be credited; but if we substitute the term energy, suggesting something immaterial, impalpable, elusive, the metaphor or analogy is so good that we are apt to regard it as more than a metaphor, therein being deceived by language, as men have been ever since words were invented.

Can We Measure Consciousness? Now, let us observe two cardinal objections to the doctrine that mind is a form of energy. We are bound, in the first place, to accept the doctrine of the conservation of energy, and hence, on this theory we must believe in the conservation of mind. Other forms of energy are never created or lost, but merely transformed; they can all be resolved into one another; they all tend to become converted into heat or kinetic energy, and they are all subject to precise quantitative measurement. Every one who has electric light in his house is familiar with the phrase *unit of electrical energy*, or *electrical unit*, a term which expresses the fact that energy is a thing which can be measured or weighed, or, so to speak, chopped off in lengths. Were this not possible, plainly we could not have arrived at the truth of the conservation of energy. If we could not measure it, we should never know whether it did not occasionally come into existence out of nothingness, or, on the other hand, undergo occasional annihilation. Now, if mind is a form of energy, the law of the conservation of energy must be shown to be applicable to it. No one has ever made even an attempt to do so. The moment the task is contemplated, it is seen to be impossible. How, in the first place, are we to measure mind or consciousness? What unit of it can be conceived? What scale like a temperature scale? There is none, nor is there the smallest possibility that any can ever be framed. Very few psychologists have yet come to realise the significance of such a phrase as the *intensity of consciousness*.

The Wise Man and the Fool. In the second place, there are demonstrable and indisputable facts which clearly prove that mind is not subject to the law of the conservation of energy; indeed, an accurate equivalent for the *conservation of energy* might be the *conservation of not-mind*. It is, indeed, true that the brain depends for its working upon the constant supply to it of food materials. It is true, also, that the heat produced by the burning up of these food materials in the brain precisely obeys the law of the conservation of energy. Yet in the course of such burning up of a given quantity of food materials, the brain of a Newton may conceive the law of universal gravitation, while the brain of a fool conceives merely a piece of folly. Indeed there is no reason for supposing that the brain of a Newton may not, on occasion, be the means of production of great mental achievements during the course of the oxidation of much less food material than may be required by another brain which is producing nothing of value.

Mind and "Not-Mind." Furthermore, the food materials employed might have been oxidised elsewhere than in the brain at all, and in either case would have produced exactly the same amount of heat energy. Whatever the circumstances, the law of the conservation of energy is strictly observed ; yet in the last case we have supposed, the transformation of energy is accompanied by no mental product whatever. If, then, the transformation of a given amount of potential chemical energy into kinetic energy may, in one instance, be accompanied by no mental products, and in other instances be accompanied by mental products varying in value from nothing at all to a value which no language can express, it is surely evident that the law of the conservation of energy is ludicrously inapplicable to the facts of mind. Universally, invariably, and rigidly true elsewhere, it is simply irrelevant when we come to deal with mind. We would insist upon this fact ; for, in the first place it absolutely disposes of the popular but uncritical and wholly false doctrine that mind is a form of energy ; and in the second place it furnishes the most striking of all proofs, in the judgment of the present writer, of the immeasurable gap, the incalculable difference, between mind and not-mind. In our opinion, the law of the conservation of energy is precisely equivalent to a law of the conservation of not-mind. It is unquestionably the greatest exact generalisation in the physical sciences, but it has no place or applicability in the science of mind.

And, finally, let us note a last objection to the doctrine—a doctrine which is, in reality, a new variety of materialism—that mind is a form of energy, like heat or motion. The objection consists of a criticism which would never occur to the physicist, but which inevitably occurs to the psychologist. For when we come to analyse this idea of energy, what do we find ? Surely we find that it is, like all our other ideas, a product, in a sense, of the mind, and dependent upon the nature of the mind itself. But, obviously, it is wholly illogical and indeed childish to assert that the mind, to which we owe the idea of energy, is itself merely a form of that energy of which we have no idea or knowledge, save in virtue of the activity of the mind itself.

Mind is not a Physical Thing. This wild notion is, indeed, absolutely parallel to the notion of Huxley, that consciousness is what he called an *epiphenomenon*—a sort of accidental and wholly unnecessary by-product of the physical activities of the brain. For Huxley, and, indeed, all who hold the view that mind is a form of energy, believe all external things (the brain included) to be *phenomena*—that is to say, appearances or things appearing to someone. That is all very well, but it does not do thereafter to regard the someone to whom the phenomena appear—*viz.*, the perceiving mind—as itself a secondary phenomenon or epiphenomenon.

What a ridiculous theory is this which regards the mind, to which all other things appear and by which all other things are known, as itself no more than an appearance—and an appearance of quite second-rate importance—being, indeed, a sort of accident : not even a phenomenon, but merely an epi-phenomenon ; not even a product, but merely a chance by-product. So much for the most widely held and most indefensible of those physical views of mind which have gained such currency in consequence of the spread of the knowledge of the physical sciences without a corresponding spread of knowledge of the mental sciences. There is no mental philosopher, nor probably ever was, that regards mind as a physical thing. The doctrine in all its various forms owes its currency to physical philosophers like Huxley and Clifford and the German materialists, who have dogmatised about psychology without any previous training in the subject, and especially without any conception whatever of that vastly important branch of inquiry which is known as *epistemology*, or the theory of the knowing process.

We cannot spare more space at present for the philosophical aspect of our subject, which is, however, supremely important, and could not be wholly ignored. Let us turn to its least philosophical and most purely scientific aspect.

The Business of the Nervous System. The reader is already acquainted with the main facts of the nervous system. He is aware that it consists of a central portion—the brain and its continuation, the spinal cord—and of an outlying portion composed of innumerable nerves. If we examine the history of the developing individual—that is to say, if we call in the science of *embryology* to our aid—we discover the extremely significant fact that the whole of the nervous apparatus, without exception, has been developed from the surface of the organism. Historically, thus, the nervous system is evidently what we know it to be for other reasons—primarily and essentially a means of recognising what is outside us. Locke knew nothing whatever about embryology ; the science did not exist in his day, but it has provided us with the most striking and significant confirmation of his view that the origin of all our ideas is to be found in sensation. For this new science demonstrates that the nervous system in its development is, so to speak, a product of the skin, a product of the exterior of the body—that part of the body which is next the external world, and which directly receives influences from it.

Plainly, this fact is in precise accordance with the view of Locke. Embryologists have proved by direct observation that the external layer of the developing embryo gives off a certain portion of itself in the form of a groove, later separated from the surface altogether and converted into a canal. This canal, lined by cells derived from the skin, ultimately becomes the central canal of the central nervous system, and the cells around it develop into the brain and spinal cord. Thus, perhaps, the first important fact for the psychologist to note concerning the nervous system is that the details of its history afford a most signal confirmation of the

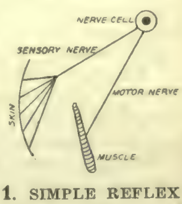
doctrine that sensation is the primary fact of mind.

The Avenues of Sensation. But the purely anatomical and physiological study of the nervous system throws even more light for the psychologist upon this very point. The reader is already aware that the nervous system consists, in brief, of nerve cells and nerve fibres. Now what do we find to be the cardinal fact of their arrangement ? It is that—to reduce the vast complexity to a simple scheme—the nervous system consists of an immense multitude of what are called *reflex arcs,* closely interconnected with one another. Now the scheme of a reflex arc is simply this : (1) a nerve fibre running from the surface of the body to the centre ; (2) a cell which receives the sensation thus conveyed ; and (3) another nerve fibre running outwards from the cell to a muscle, which tends to contract—this being the ultimate consequence of the passage of the sensation along the centre-seeking nerve. This contrasted pair of nerve fibres, together with a nerve cell, constitute the simplest possible representation of a reflex arc. All the nerves that run centrewards are called centripetal (that is, centre-seeking), or afferent or *sensory ;* while those running outwards from the central nervous system to its servants, the muscles, are called centrifugal or efferent or *motor.* The simplest conceivable nervous system consists of just one such reflex arc as we have described. The nervous system of man consists of millions of such arcs all joined up with each other, so that one afferent impulse may give rise to an efferent impulse in one or another of thousands of efferent nerves ; while, on the other hand, one and the same efferent nerve may be excited in consequence of a sensation incoming through any one or any set of thousands of afferent nerves.

Everything Has Sensation. It has already been briefly noted that the French thinker Descartes must be credited with the first clear understanding of reflex action. Today this subject constitutes one of the most important in the whole realm of psychology, not only on account of its own interest, but because of its all-important bearings upon the whole subject of will. The description of a reflex arc already given makes plain the meaning of a reflex action ; but instead of considering one such reflex arc, let us consider the nervous system of man. What we find is that the reflex arcs of the human nervous system are arranged in an ascending order of control, so that—in a fashion it would take a volume to discuss properly—the higher levels of the nervous system are able to control and determine the behaviour of the lower levels. Furthermore, the whole series of occurrences in these lower levels of the nervous system is almost entirely unknown to our consciousness. Hence it is extremely common to describe reflex action as action which is independent of sensation. Now the physiologist may let pass such a phrase, but the psychologist certainly cannot. The psychologist is assured that away down in these little-understood regions of the nervous system sensations of sorts certainly occur. It is impossible to regard any reflex action as independent of sensation. Sensations cannot be denied even to the simplest living cell that has no nervous system at all. No one can question the occurrence of sensation in the lowest organisms who has watched through the microscope a conflict between a white-blood cell and a microbe.

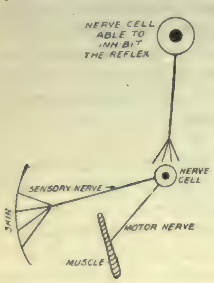
Self-control of the Nervous System. On the contrary, we must define reflex action as action which is independent of the will. We must drop altogether the old distinction between a *reflex* act and a *sensori-motor* act. We must regard all reflexes as in reality *sensation-reflexes ;* and the two great classes of acts which we must distinguish are the *sensation-reflexes* and *voluntary acts.* We are now able to understand the significance of what has been said regarding the control exercised by the various levels of the nervous system upon the levels beneath them. This control has the technical name of *inhibition* —one of the most important terms, since it expresses one of the most important ideas, in the whole of psychology. In virtue of this power the higher levels of the nervous system, and especially the highest level of all, are able to control the lower levels—that is to say, the lower reflex arcs—in such a way as to arrest completely the performance of reflex actions which would otherwise take place. Indeed, we may regard self-control—that is to say, the self-control of the organism as a whole—as the most important function of the higher levels of the nervous system.

Is Movement Unconscious ? Reflex action is simple enough to understand ; we can readily figure to ourselves the passage of nervous energy inwards along a nerve, the termination of which has been stimulated by, for instance, a ray of light. Then we can conceive how this nervous energy is transformed in the nerve cell and passes outwards again to a muscle, which moves in consequence. That, essentially, is just what happens when we close our eyelids in consequence of our vision of something which threatens the safety of the eye. But suppose we take the case of the boy who is able to keep his eyes wide open in spite of the tendency to close them when another boy makes the action of striking him in the face. It is incalculably more difficult to understand what happens in such a case ; but, at least, we can draw a diagram which clearly indicates the state of affairs and which, though so simple, does really correspond to the actually observed facts of the anatomy of the nervous system [see 1]. In 1 we have a simple reflex arc, the afferent, centripetal, or sensory impulse from the skin being transmuted in the nerve cell into an efferent, centrifugal, or motor impulse, which throws a muscle into responsive or reflex action. In 2, however, we see the same reflex arc under the rule of a nerve-



1. SIMPLE REFLEX ARC

cell lying at a higher level in the nervous system, which is enabled, by means of its nerve fibre, to inhibit the reflex, or allow it to proceed, according to circumstances.



2. REFLEX ARC WITH INHIBITION

Now there are two opposed views, both of extreme interest, which are held as to the interpretation of these facts. The older view is that advanced by Herbert Spencer in his pioneer study of the evolution of the mind. For convenience, we may express it in a much more extreme form than he ever held. In this extreme form, the theory would be that all movement is originally unconscious and reflex, and that the will has been evolved from reflex action and from the gradual control of reflex action by the remarkable faculty of inhibition.

Voluntary Actions Become Automatic. On the other hand, there is the theory which has been advanced by Spencer's successors, and notably by Prof. Wundt, that all movement is originally voluntary and purposeful—even the simplest movements of a microbe, for instance. Wundt maintains that, as the animal world has evolved upwards, the conscious and deliberate factor in the large majority of movements has disappeared, and they have become reflex. Thus, for him, will is not evolved from reflex action, but reflex action from willed or volitional action. Both Spencer and Wundt insist upon the remarkable fact with which we are all so familiar, that actions which were formerly under the immediate and continuous control of the will constantly tend, when practised, to become reflex, involuntary, automatic and unconscious. This is true of walking, for instance, of learning to play any game of muscular skill, and, indeed, it is true of nine-tenths of all the actions which we perform.

The controversy is far too long and too difficult to be pursued here. Enough, if the reader notes the existence of this difference of opinion amongst psychologists as to the historical relation between reflex and voluntary action. Every reader who cares to think about the subject at all will be able to evolve for himself many arguments, some of which will tell on one side and some on the other. If space availed, it might be shown, we think, that with a little modification the opposing views can be reconciled.

Sensation and the Senses. We are all familiar with the five senses—the five gateways of knowledge—and, unfortunately for the progress of psychology, we are apt to think that there are no more. But even confining ourselves to external sensation alone, we very soon discover that, in the first place, certain animals appear to possess senses unknown to us, and in the second place, that our own senses need analysing. Take, for instance, the so-called sense of touch: we actually include, under one term, a whole series of senses, each of which has its own special kind of sense organ, which are definitely known to be conveyed in special and independent paths of their own along the spinal cord. The word *touch* should really be applied to the *sense of resistance.* In addition to this, there is the sense of *pain,* which takes a nervous path of its own; the sense of heat, and the sense of cold. These last two are quite distinct from one another. Our skin, indeed, is covered with "hot and cold spots," of which the first appreciate a rise in temperature, while the second appreciate a fall in temperature.

Our Many Senses. But, in addition, we have a number of internal sensations which are of the utmost importance. There is, for instance, the so-called muscular sensation, which informs us of the position of our limbs and the various parts of our body in space. This, however, appears to arise less in the muscles than in the joints, the skin, and the structures called tendons, by which the muscles are attached to the bones. Without the muscular sensation it is absolutely impossible to do any muscular act of any complexity at all. It is, for instance, quite impossible to stand, let alone walk. Closely allied to this—in, at any rate, its value for us—is the *sense of equilibrium* or equilibration. The function of this is to enable us to preserve our equilibrium, and it has a special characteristic end-organ of its own, known as the semicircular canals, three of which lie in the three axes of a cube or the three dimensions of space, near the internal ear on each side of the head.

By way of showing how imperfect was our knowledge of psychology when we used to talk of the five senses, it may be noted that it is absurd to speak, as we do, of the *auditory nerve,* as if it were the nerve of hearing alone. It has scarcely yet been fully appreciated that the organ of hearing and the organ of equilibration, the internal ear and the semicircular canals, though so close together, are yet two independent organs of two independent senses, each having its own independent nerve fibres. The auditory nerve, so called, is thus really two distinct nerves—the nerve of hearing and the nerve of equilibration; and of this there can be no doubt when we find, on tracing the nerve fibres to their ultimate destination in the brain, that the fibres of one sense soon part company from those of the other, and the two sets run to two very different parts of the brain, so remote, indeed, that they have scarcely any connection with one another.

Briefly alluding to other internal senses, such as the sense of hunger and the sense of thirst, we must note the existence of an enormous group of slight and vague, but important, sensations which reach us from our internal organs.

The Sense of "Feeling Fit." The phrase that best describes the whole mass of vague and barely recognised sensation which reaches us from our internal organs is undoubtedly *organic sensation.* In health, the total result of this group of sensations upon consciousness is usually described as the *organic sense of well-being.*

This sense of "feeling fit" or "in good form" may be regarded as, on the whole, the most valuable sign of health that exists. In a very large number of diseased conditions, the organic sense of well-being, which is, at bottom, the most important factor of all in the happiness of every man and woman, is abolished; or, worse still, is replaced by an organic sense of ill-being which is more or less familiar to all of us and which is the most radical and essential character of that whole group of diseases of the mind which are usually classed under the name of *melancholia.*

Perhaps the due recognition of the importance of organic sensation is as important as any of the discoveries of physiological psychology. For it provides us with the key to the understanding of many of the mental symptoms of various diseases; a recognition of it is essential to the student of insanity, and it is of immense importance in understanding what we may call the normal mind, and especially the varieties of emotional character, of temperament, and of mental energy.

"Seeing by Memory." In so brief a course as this, it is necessary to deal with the whole subject of sensation very concisely, but before we leave it, we may at least describe in outline what is perhaps the most important instance of the building-up of our sensations into complex ideas. Kant, as we have seen, regarded our idea of space as a "form of the mind," inherent in its constitution, and not given in experience; but now we know very differently. By a series of observations and experiments, we have been able to prove that our idea of space is built up from a large number of indications furnished by many and various senses. There is, perhaps in the first instance, the sense of vision. When we look out of one eye we perceive things in two dimensions of space only, *breadth* and *height;* we see them on the flat. The reader will certainly and rightly question this statement; he will say that when looking out of one eye he does not see things on the flat; but we now have to remember that all the sensations of adult life are complicated by memory and experience. These it is which give us the impression of depth and perspective, even when looking out of one eye, though it is undoubtedly the case that the image which is planted on the retina has only two dimensions, and that external objects would appear to be all in one plane to an eye which had not been instructed by past experience.

How We Realise Space. In what is called binocular vision, however—that is to say, vision with two eyes at once—we receive two views of one object, which differ in, literally, their point of view; they are taken at slightly different angles. Our combination and comparison of the two images thus formed gives us the impression of *depth* in addition to the impressions of breadth and height for which one eye alone would suffice. Vision is thus certainly an important factor in the formation of our ideas of space, but it is doubtful whether other factors are not of greater importance. Great value must be attached to our sensations of movement, reaching us from the joints, muscles, and skin, whereby we become acquainted with the position of the various parts of our own person in space, and which undoubtedly contribute towards the gradual formation of the idea which to the adult's mind seems so obvious. And of no less importance is the organ of equilibration, the six semicircular canals, three on each side of the head, which are arranged in the three dimensions of space.

Movements of the head, in any direction or combination of directions, are unfailingly registered in health by means of a corresponding movement of the fluid in one, two, or three pairs of these canals—such movement stimulating the ends of the nerves of equilibration, and being appreciated probably by the cerebellum or hind brain. Hence it happens that after long rotation in one direction—as, for instance, in waltzing—we acquire a giddiness that can be relieved by "reversing," which reverses the direction of movement or pressure of the fluids in the horizontal pair of semicircular canals.

In the lowest vertebrate animals we do not find these canals at all; they are not present, for instance, in the fish; they occur in birds, however, and the physiologist Flourens was able to prove, by observations on the pigeon, how close is the connection between each pair of semicircular canals and movements of the head in the corresponding direction. Observations in what is called "Ménière's disease"—the chief symptom of which is giddiness, and which is due to disease of these semi-circular canals—have shown that the giddiness which ensues from disorder of these canals corresponds to the direction of the particular canal or canals which may be affected. If these, for instance, be the horizontal canals, it is the movement of shaking the head, or movement in the horizontal plane, that upsets the equilibrium of the patient.

What is Space? Some years ago the argument was advanced by the present writer that the number and arrangement of the semicircular canals may be regarded as a proof, or at any rate a fact tending to prove, that our idea of the tri-dimensional character of space is a true one. The philosophers known as idealists, for instance, deny that any real validity can be attributed to our belief in the tri-dimensional character of space; while the mathematicians have invented what they call *hyperspace,* and can construct theories or solve problems concerning space of four dimensions or of *n* dimensions.

Now, it is certainly no argument in favour of the actuality of our tri-dimensional notion of space that the organ of equilibration consists of three canals at right angles to each other. Indeed, our opponents may say that we believe space to be tri-dimensional simply because we happen to have a tri-dimensional arrangement for appreciating it. But evolutionary considerations, we believe, raise another question, and it is this: If space be not really tri-dimensional, why should there have been evolved within our heads a tri-dimensional arrangement for appreciating our

position in it? Surely the evolutionist's answer to this question would appear to be that the fittest type of organ of equilibration survives; that the fittest or most useful type of such an organ would be one that most truly acquainted its possessor with the fact; and thus that the tri-dimensional character of the organ of equilibration is most satisfactorily to be explained on the ground that space *is* tri-dimensional, and so favoured the evolution of an organ having this character.

But whatever the truth on this matter may be, it is, of course, quite idle any longer to speak of space as a *form of the mind.* On the contrary, we have to recognise that our idea of space is a gradual and complicated acquirement, dependent upon the long and co-ordinated experience of many different senses. Whether the idea is in true correspondence with external reality, we cannot indeed say; and though that is a question of even greater interest, it is, at any rate, a very great advance to have achieved an understanding of the idea of space, such as was entirely impossible for the psychologist who died scarcely more than a century ago.

Our Senses Help Us to Stand. Finally, we must note that the success of equilibration—that is to say, of preserving our balance—and also that success in all those arts and games and technical procedures, such as threading a needle or building a Forth bridge, which depend upon an accurate estimation of space—that such success is conditioned, not by any form of the mind, but entirely by a due co-ordination of all the senses that are involved. It was stated above that the fact of balancing ourselves is accomplished by means of the semicircular canals—that is to say, by the organ of equilibration. But it is of great significance to observe that the indications of this organ alone are quite inadequate for all our practical purposes, just because our idea of space depends upon so many other indications beside those which it furnishes. The nerves of the soles of the feet, for instance, are of great value in helping us to balance ourselves when standing. If these nerves are thrown out of action—as by painting the soles with a strong solution of cocaine or some other local anæsthetic—the art of standing erect is made much more difficult. Our eyes are also of great use in helping us to preserve our equilibrium. In the lamentably common nervous disease known as *locomotor ataxia*, the spinal cord is so affected that sensations cannot properly travel from the soles of the feet or from the muscles, joints, and skin, which are involved in the act of standing. In very severe cases, the eyes cannot save the situation; but in much less severe cases the patient may be able to stand erect with his feet placed close together, so long as his eyes are open. When he shuts them, however, the task of preserving the bodily balance is found to be too much for the unaided organ of equilibration, and the patient sways and falls.

Co-operation of all the Senses. One other term which should be familiar to every student of psychology must be discussed in this connection. Not one of the purposes for which we employ any of our muscles could be accomplished if we were not able to combine various muscular groups for particular movements and, very often, to control the movements of those groups by setting in action, though much less powerfully, other groups of muscles which tend to oppose them. In bending the arm slowly, for instance, it is not the case that the action depends solely upon the contraction of the biceps muscle. There is also acting, all the time, the muscle on the back of the arm which is known as the triceps, the unopposed action of which would be to extend the arm. If it were not for co-ordination our lives would be impossible. The power of acquiring this amazing art, which is exhibited in every voluntary action and in very nearly every reflex action, depends upon the combination and co-operation of all the senses, chiefly and most essentially for the establishment of an accurate and constant and invariable idea of space.

A Great Discovery. The term *co-ordination* is commonly used by psychologists of actions or movements, but it should just as properly be applied to sensations. It is by means of the co-ordination of an extraordinary number and variety of sensations that we obtain the idea of space, which without co-ordinated movement would be impossible. The co-ordination of motion depends upon the co-ordination of sensation, and too much emphasis cannot be laid upon the complete reversal of Kant's doctrine regarding this, which is, perhaps, the most important of all ideas. That which Kant thought to be a form of the mind, prior to all experience, conditioning all experience and interpreting all experience for us; that which he thought to be a simple and indivisible form of knowledge, is now known to have the most complex and varied origin in the co-ordination of the indications of senses having their localities as far apart as the eyes and the soles of the feet. This great discovery is, perhaps, the most precious fruit of the recent union of psychology and physiology.

Continued

THE VIOLIN

The Demands of the Instrument. Names of the Parts. Buying a Fiddle. The Strings and Bow. Tuning. Time. Exercises

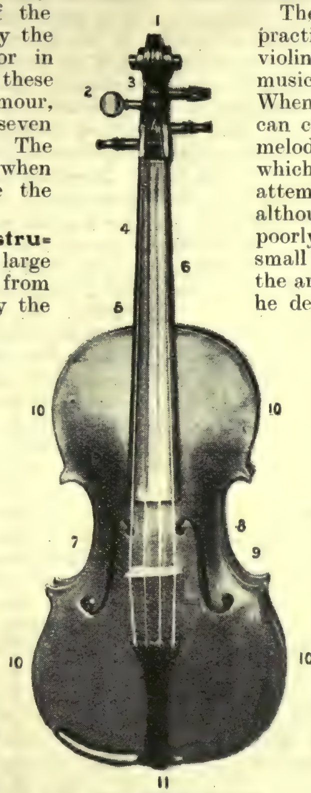
Continued from page 2036

By ALGERNON ROSE

THE precursor of the violin was the viol of the Middle Ages. As early as 1200 the word "violin" is mentioned in the legendary life of St. Christopher. It is an abbreviation of the Italian violino, the latter implying the diminutive of the great violone, or double bass. There were four chief patterns of viols. The smallest of these, termed the treble, or discant viol, was superseded by the Italian violin. The next size interpreted a deeper part. It was known then, as now, by the name of viola. Thus, our tenor violin is the only instrument of the group of fiddles retaining to-day the name borne by its predecessor in mediæval times. Certain of these tenor viols, like the viol d'amour, had seven fingerboard and seven additional strings underneath. The latter, vibrating in sympathy when those above were bowed, gave the instrument a peculiar quality.

Construction of the Instrument. The violin, whether of large or small pattern, is differentiated from all other musical instruments by the strings being set into vibration through the friction of rosined hair. In the old rota, and, later, the hurdy-gurdy, this was effected by means of a wheel instead of a bow. In the violin we have a survival of the fitter method.

Votaries of the violin point to the fact that, whereas other instruments are always being modified or improved in some way, during the past three hundred years the fiddle has undergone no change in construction. Considering that sensitive musicians are somewhat given to fault-finding, and that thousands of them have not only been entirely satisfied with the instrument, but have shown an intense love for it during that long period, the beginner may well regard it with reverence. Apart from this, since violin evening classes have been instituted by the London County Council, it is evident that we are on the eve of a popular development in violin playing. Although a temporary check may have been put on pianoforte teaching, owing to the spread of mechanical players, there is little likelihood of the inventor encroaching on the preserves of the violinist.



1. THE INSTRUMENT

Practice. The importance of the violin cannot be overestimated. It is the chief, or leader, of the group of bowed instruments which forms the basis and body of the material constituting the modern orchestra. The greatest of the composers, therefore, have made a careful study of the violin and its kindred. At the same time, although indispensable for the achievement of collective effects in a concert-room, there is no other orchestral instrument which can show such a roll of honour of world-famous solo players.

The instrument demands industrious practice. The fact that to excel on the violin is at first uphill work makes a musical hero of the successful student. When he presently discovers that he can captivate his hearers by a simple melody, after the mastery of studies which appeared impossible when first attempted, he has his reward. Thus, although violinists, as a body, may be poorly paid, the instrument itself in no small measure mentally compensates the artist by the ever-growing pleasure he derives from his close association with it.

The Parts. The pianist may win a scholarship at a chartered institution without knowing why the bent side of a grand is on the right instead of the left of the keyboard, or without being able to describe the difference between a hammer-butt and a balance-rail. But the fiddler prides himself on understanding every detail of the anatomy of the violin. As a consequence he looks after his instrument more intelligently. He is able to comprehend its many moods—for a fiddle can catch cold like a human being. If properly cared for, it recompenses the player by the extra pleasure it gives.

The student should now turn to **1**; the numbers attached refer to the different parts.

The *Scroll*, or *Head* (1). Its base forms the *Peg-box*. This bears the strain of the four strings, approximating to 68 lb., but the total pull of a heavily-strung fiddle has been known to reach 80 lb. The weight of the scroll also gives as much equipoise to the instrument as the extra heaviness at the stock of a rifle makes that weapon more easy to handle. The carved curls

at either side of the cheek are called *volutes*, an architectural term denoting the spirals in Ionic and Corinthian capitals.

The *Tuning-peg* (2). It is bored in the shank with a *String-hole*. If the peg be too firm, ease it by rubbing it with a little dry soap.

The *Peg-hole* (3) is bored through both cheeks of the peg-box. The lowest hole bears the heaviest string, the next the lightest, the one above the second heaviest, and the top hole the second lightest. In this manner the strain is distributed evenly.

The *Neck* (4). This is covered in front with the ebony *Fingerboard* (6). No matter how good the tone of the *body* of the instrument may be, if the neck is not well proportioned and the fingerboard fixed at the proper angle, the cleverest player cannot make the fiddle sound to advantage.

The *Shoulder* (5). The shoulder is the part under the base of the neck. It supports the hand of the player when fingering in an upper register.

The *Belly* (10), carved in an arched or bulged-out manner, is pierced by two sound-holes (7 and 8). These, on account of their shape, are called *f holes*. The belly, being of silver pine, the most elastic of known woods, acts as a resonator, and amplifies the initial tone which comes from the strings down through the *Bridge* (9). So as to get the pulsations of the strings swinging through its two feet over the whole soundboard and the body of the instrument, it is important that the bridge should be of the right height and material. Hard beech is most satisfactory. On the top of the bridge are four *chimbs*. If these nicks get too deep, the strings, when tuned up, will rise in jerks instead of stretching smoothly. The inlaid lines, of black wood between fine strips of white plane-tree round the margin of the belly, are known as the *purfling*, which, by binding the fibres together at the border, preserve the edges of the instrument.

The "Body." The belly is connected by curved *sides*, of a carefully calculated depth, with the *back*. These three parts form the *body*, which is so graduated internally as to enclose a mass of air necessary to produce 512 vibrations per second. Jammed between the belly and the back is the *soundpost*. Without this little rod, the violin lacks its sustaining qualities. By uniting the opposite sides, the soundpost permits the circuit of vibration to complete itself, and enables the sound-waves to act and react on each other freely. Another great nerve in the fiddle under the belly is the *bass-bar*. This extends from the left foot of the bridge in a slightly slanting direction. To explain the influence of this bar, it may be mentioned that every piece of wood has a definite tone when struck, if one has the ability to hear it. The great fiddle-maker, Stradivarius, on completing a belly of sonorous pine, found that it emitted the note C. After cutting the *f* holes, the pitch was lowered half a tone to B. Thereupon, he accelerated the vibrations by adding a bass-bar. This raised the sound to D. He then reduced the thickness of the bar until the belly responded with the note he wanted, C. But if the belly sounded C he tuned the pitch of his backs to D, always a tone higher.

For the *Tailpiece* (11), glass, ivory, and various metals have all been tried, but plain ebony is best. It will be noted that between the edge of the tailpiece and the bridge there is a space of about $1\frac{3}{4}$ in. where the strings are not played upon. The length of this un-bowed portion is mathematically calculated. It has a great influence on the character of the tone. Although the bowing is done below the bridge, when the long segment of the string there is set into vibration, the unused remainder of the strings reinforces the sounds by emitting what are called overtones, which add to the brilliancy of the notes. These sympathetic upper partials may not be perceptible to ordinary ears. If a piece of heavy felt is wrapped over the strings from the tailpiece almost as far as the bridge, the difference in quality can be proved. At the broad end of the tailpiece are four slots, or eyes, to receive the ends of the strings. The outline then diminishes before it terminates. The small bulb at the end is called the *saddle*. In this are a couple of holes. These receive the *loop* of thick black gut which fits round the *tail-pin*. The latter is fixed firmly into the *tail-block*. This, before being glued into its place, furnishes a spy-hole for the maker to see that all is right inside before he closes it up.

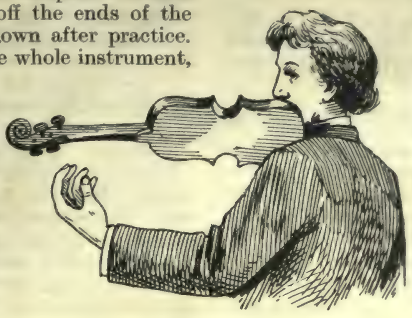
Buying a Fiddle. When choosing an instrument, do not expect to pick up a bargain for a small sum, especially at a pawnbroker's. Refrain from answering catchpenny advertisements, and disregard an old name on a label inside any instrument offered for less than two figures. In every large town a repairer of violins is to be found. Seek out such a craftsman. His tribe is invariably enthusiastic, and useful hints may be gained from him.

Because great players possess old instruments bearing famous names, it does not follow that an ancient fiddle is invariably better than a modern one. The reverse is the case if the purchase is limited to about £2. For that sum an excellent copy of a good model may be obtained from well-known London firms, such as Hill, Withers, or Hart. Unless the beginner's fingers are diminutive, it is better to get a full-sized instrument. In the former case, a three-quarter or even a half-sized instrument may be advantageous. In the latter instance, the length of the string from the bridge to the nut on the fingerboard should be approximately 13 in., and the total length of the body nearly 14 in. If the violin is required for orchestral work, choose a flatter belly than if for solo playing. A flat model has more penetration of tone. A fuller curve is calculated to produce more mellowness, or sweetness.

Strings. The same consideration applies, in a lesser degree, to the gauge of the strings used. A set of the thickest gives fulness at the expense of brilliancy, whilst the thinnest give brilliancy at the expense of fulness ; moreover, the latter are more liable to break. Medium gauge is preferable. Before putting on a string, see that it has not become untwisted. Make a small loop at one end of the thinnest, or E string. Slip this through the aperture

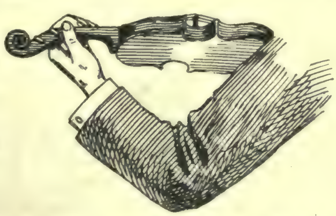
in the tailpiece. Draw the rest of the string through the loop. With the other end, thread the eye of the tuning-peg. A pair of tweezers is useful for drawing the end through the other side. The other three strings do not require a loop; a double knot suffices to keep them in their places on the tailpiece. After screwing up the pegs, cut off the ends of the strings. Do not let them down after practice. This alters the tension on the whole instrument, and when they are screwed up again they will never keep in tune.

The Bow. If a serviceable violin can be purchased for £2, a suitable bow is obtainable for 5s. or less. In selecting, be careful to get a straight, flexible and light stick. The whole should not exceed 2½ oz. in weight. See that the screw works properly. The best hair is that from the tail of a white horse. One hundred hairs are used, and they should not cross over one another. The hair of horses is whiter and less greasy than that taken from mares. Some players nowadays affect very long bows, several inches in excess of those of the celebrated Tourte pattern. Avoid extremes. Choose a bow of medium length. Get a box of purified rosin for a few pence.


2. CHIN-AND-SHOULDER GRIP

Another small item usually incurred is the purchase of a "chin-rest." Great players formerly were content to make a pad of their handkerchief. But a plain ebony chin-rest gives increased firmness when holding the instrument. Spohr's fiddle-holder was fixed immediately over the tailpiece. Nowadays, the accepted place is to the left of the tail-piece over the body of the violin. An advantage claimed for the chin-rest is that it does not damp the vibration of the belly, as is partially the case when the latter is pressed by the lower jaw.

Soundpost and Bridge. Sometimes an otherwise good fiddle may sound very dull in tone owing to the wrong position of the sound-post. This little cylinder inside the instrument, as has been explained, supports the bridge, and is placed under its right foot. The middle of the left foot of the bridge must stand exactly over the bass-bar, the position and breadth of which can be discovered by a thin hooked wire being inserted through the *f* hole. A slight adjustment of the soundpost, with what is called a sound-post setter, may greatly improve the tone.


3. KEEPING THE WRIST DOWN

Or perhaps the reason of the dulness is because the bridge is too high. The outline of the top of the bridge is regulated by the arching of the belly. It always slopes more over the E string than over the one covered with wire, so as to enable the latter to be more easily bowed. The back edge of the feet of the bridge should be in a line with the inner notches of the *f* holes.

Tuning. Each of the four strings of the violin has a different gauge. The thickest of the four is the D, although that does not give the lowest sound. The bass string, being artifically weighted with wire, is only a little thicker than the A, or second string. Copper-covered strings are less expensive than those with silver. Their tone is often as good, but their surface is more apt to corrode. When a gut string is put on the tone is sometimes false. This may be due to an error in the make, or to the fact that the string has perished. A dull or spotted appearance indicates the latter condition. Good strings are pale yellow, transparent, and glossy. In any case a false string is worthless. To keep spare strings in good condition, enclose them in an air-tight box wrapped in oil-silk. Always buy the best quality of strings. Avoid "acribelle," or silk strings; they are liable to fray, and their sound is generally undesirable.

Tune the second string to A—second space, treble clef—by a tuning-fork or piano. If a piano is unavailable, sets of four pitch pipes can be obtained for a small sum. If too low in sound, screw the string up gradually. It may break if the tension is increased suddenly, or the string is wound too far. When turning the peg and twanging the string, watch the bridge. If the string pulls it forward, release the strain slightly, or the bridge may fall and break.

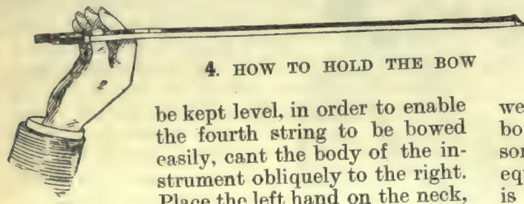
Tune the third string to D, a perfect fifth below A, and the fourth string to G, a perfect fifth below D. Lastly, tune the first string to E, a perfect fifth above the A of the second string. If it does not sound flat enough, a pressure of the thumb along the string should suffice to stretch it to the lower pitch without further screwing. If the pegs are loose and they run down, chalk will make them hold better. These four strings give the natural, or "open" notes of the violin.

Attitude. The first exercise is to learn to bow the four open notes properly. To do this, the beginner must hold himself and his violin correctly. He will be seen at his best—as well as at his worst—when he plays standing. Hold the body erect. Keep the feet slightly apart. Throw the weight on the left foot. Avoid assuming any position which is unnatural. Nothing looks worse than a fiddler who stoops, sticks out his elbows, or lets his instrument droop in front whilst he scrapes on it limply.

Left Hand. Hold the violin by its neck with the left hand. Lay the tail-end of the

instrument upon the left collar-bone. Advance the left shoulder slightly to receive the violin. Incline the head to the left; place the chin on the chin-rest to the left of the tailpiece. The grip between chin and collar-bone should be sufficient to hold the violin horizontally without assistance of the left hand [2].

It is better at first to incline the fiddle a trifle up rather than downwards. Although the axis of the violin from the tail-pin to the scroll should



4. HOW TO HOLD THE BOW

be kept level, in order to enable the fourth string to be bowed easily, cant the body of the instrument obliquely to the right. Place the left hand on the neck, with the thumb to the left and the fingers over the strings. Do not let the neck drop into the hollow of the thumb. Instead, regard the thumb and first finger as a two-pronged fork. Whatever pressure is necessary should be between the ball of the thumb and the second joint of the first finger—half-way up the prong. At the base of the fork, the player must keep a free space, so that "daylight" may show between the two digits [3].

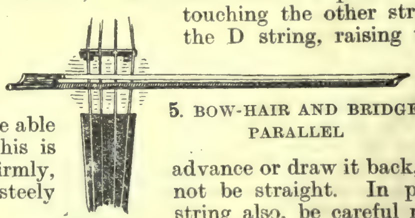
The object of this rule is to keep down the wrist as vertically as possible, well under the neck, so that, later, when the hand is shifted up the fingerboard for playing high notes, it may move freely and uniformly. The tendency of the beginner is to let the wrist advance to support the neck. This is a bad habit, and must be avoided. The instrument should not require any such assistance if held properly by the chin. The thumb acts as a rest rather than a vice when in contact with the neck.

Bend the elbow to the right, well under the centre of the instrument, without leaning it against the player's body. It constitutes a zigzag bracket, which should be free to swing laterally. Paganini, the greatest of fiddlers, crooked his elbow in such a way that it came out at the right side of his instrument. But he was a phenomenon. In violin playing, the position should be as graceful as possible. If good tone is to result, the fingers must be able to move freely and independently. This is only possible when the fiddle is held firmly, and at the same time with a certain steely flexibility.

Right Hand. Having rosined the bow thoroughly from tip to nut, take it up with the right hand [4]. Place the thumb in the hollow in front of the nut, or screw-slide. Rest the first, second, and third fingers on the back of the stick, pointing them to the screw end much in the manner that one holds a pen. The place of the first finger is at the end of the silk wrapped round the stick, which gives it a good hold. The fingers should not touch the hair. While the first finger encompasses the stick, pressure between the second finger and thumb mainly controls the bow movements. If it is necessary to keep the joints on the left fingers well up over the strings, it is equally desirable that the right wrist should be held high, while the fingers, pointing down, are kept close together on the stick of the bow. Do not project the right elbow; hold it close to the side.

Exercise on Open Notes. Place the tip of the bow on the first string midway between the bridge and the end of the fingerboard. Press the tip on the string. Play the open note E, keeping the body steady. Push the whole length of the bow slowly upwards across the string. Instead of trying to crush the tone out of the string by means of downward weight, cultivate a lateral pressure. Pass the bow along firmly, with its stick inclined somewhat to the right, as if cutting the string equally with a sharp knife. What is wanted is not vertical, but an even sidelong weight. To get this, keep the bow parallel with the bridge and at right angles to the strings until the nut is reached [5]. As the bow ascends, curve the wrist gradually more and more; make the wrist movement artistically. If the beginner has a chance of seeing Lady Hallé play, he will understand how beautifully this can be done. The action should be light rather than heavy; but whilst supple, there should be no display of weakness. As slowly, draw down the bow until the tip again reaches the string. Throughout each bow movement, the stroke should be of equal length and equal duration. Do not be discouraged if the effect is rough and squeaky; the coarseness will diminish with practice on the beginner bearing in mind to try always to cut the string figuratively by the sharpness of the bow.

Having tried the E string, take the A. Simple as it may seem, to hold both the instrument and bow correctly requires as much self-discipline as holding a rifle in order to shoot properly. As the A string is higher than the E, begin with the nut of the bow slightly elevated, compared with its position on the first string. Do not be satisfied until the note is produced steadily without touching the other strings. Then take the D string, raising the right elbow a little; lastly, go to the G. The elbow is now more elevated; take care not to advance or draw it back, or the bowing will not be straight. In playing the fourth string also, be careful not to let the wire buzz on the fingerboard. In some fiddles, where the covered string chatters chronically under pressure of the bow, the defect has been cured by a slight hollowing of the fingerboard at its wider end, so as to give increased space for the vibrations.

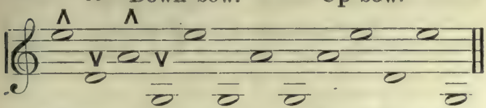


5. BOW-HAIR AND BRIDGE PARALLEL

Repeat the foregoing exercise quicker, bowing four strokes to each string. A flute player, when he practises, cannot count aloud. Make use of the advantage which the violinist has in this respect. Imagine that the beginner is a recruit on parade, and is being drilled by numbers. On

the word "one," pass the bow up its full length; on "two," bring it down firmly; on "three," pass it up again; and on "four," bring it down. Without break, continue the motion on the A, D, and G strings. After four more strokes on the G, return to the D, the A, and finish up on the E. Still counting, next proceed to leap from one open string to another, and then play two open notes at one time, thus:

Λ = Down bow. V = Up bow.



Stopping. Hitherto, the left fingers have been clear of the strings. The beginner will now begin stopping the notes. Remember, whilst doing so, to keep the left wrist down and get daylight between the thumb and the base of the first finger. Practise these preliminary exercises in front of a looking-glass, so as to contract no bad habits as regards position. See that the scroll of the violin is kept well up, that the bow does not sway from side to side, but passes parallel with the bridge, and that the movements of the arm and body are not jerked, but are made easily.

Now press down the fleshy tip of the first finger on the first string tightly, near the nut of the fingerboard, so as to form a half-tone, F, above the open note E. When the finger goes down, the violin must be kept still, and the ball of the thumb will resist the pressure. Count three. On the word "one," bow the F evenly and clearly; on "two," take off the first finger. With the down bow, play the open E. As the stopped note was less clear than the open note, try the F again with the up bow, pressing the finger well down. Continue on the second string. On this, put down the second finger; it should produce C, a third above the open note A. Count three. On the word "one," play the C; on "two," the open A; on "three," make the C sound better than it did before. Get it well in tune. Proceed to the third string. On this, put down the third finger to produce G, a fourth above the open D. As the third finger is weak, press with emphasis. Count as before. Sound with the up-bow the stopped note G, with the down bow the open D, repeating the up-bow in order to do better than before.

Advance to the fourth string. On this, put down the little finger to stop D, a fifth above the open G. Although the fourth finger is the smallest member of the hand, it is important to the violinist; being the smallest, it should receive special attention. Keeping the midget down firmly, on the word "one," sound the D with an up-bow; on "two," raise the little finger and play the open G; on "three," repeat the up-bow, getting a better result. Try the G string exercise again; then go back to the third string; put down the fourth finger with that also, and stop A, a fifth above the open D. Proceed to the second string; put down the third finger, sounding D, a fourth above the open A.

Lastly, put down the second finger on the first string, stopping G, a third above the open E. To make the motions even, it is advisable to practise with a metronome, as drummers do in the Army. If a metronome is not available, regulate the strokes of the bow to so many ticks of the clock. Avoid beating time with the foot, and do not sway the body.

Time. We have laid stress on the desirability of the student drilling himself by numbers. From the onset he should appreciate the value of playing in time. He should realise that each bar in Common Time is marked by four equidistant beats. However long or short various notes or passages played within one bar may be, the four beats should pulsate as regularly as the heart. Many amateurs who take up the fiddle as a pastime fail to cultivate this feeling. The result is that they may gain considerable facility in playing, but are as useless in an orchestra as a civilian who takes a place among a body of soldiers and cannot march in step. He throws the others out. To emphasise the first beat of the bar, it is the rule to play it with the down-bow, the down-stroke being slightly heavier than the up-stroke because of the influence of gravity. For that reason, to make the bowing equal, the player unconsciously gives a slight extra pressure with the up-bow.

Continued

COOKERY RECIPES

How to Prepare various Vegetables: Cauliflower au Gratin, Curried Mushrooms, Asparagus with Vinaigrette Sauce, Vegetable Scallops, etc.

VEGETABLES

Boiled Potatoes

INGREDIENTS. Potatoes, salt, water.

Method. Choose potatoes of about uniform size, when possible. Wash and peel them thinly, laying them in cold water as you do so. Put them in a saucepan with enough cold water to cover them, add two teaspoonfuls of salt to each quart of water and let them boil gently till they can be easily pierced with a skewer. Then drain off the water, put the pan back on the stove, shake it about occasionally until the potatoes are dry and floury. New potatoes should be put in a pan of boiling water, and beside the salt should be added a sprig or two of mint.

Boiled Cabbage

INGREDIENTS. The greens, water, salt and soda.

Method. Trim off the thickest stalks and lay the leaves in a pan of strong salted water, to draw out the insects. Next wash them carefully under the tap, put them in a pan of fast boiling water to which has been added one tablespoonful of salt and a pinch of soda to each quart of water. Boil them fast with the lid off the pan till the stalks are tender, then drain them through a colander, with the exception of Brussels sprouts, press them well.

Peas, French beans, Brussels sprouts, savoys, or broccoli are practically cooked in the same way, but for peas add a sprig of mint and a lump of sugar.

Cauliflower au Gratin

INGREDIENTS. One cauliflower, half an ounce of flour, one ounce of butter, one and a half gills of milk, two ounces of grated Parmesan cheese, salt, pepper, and a dust of nutmeg, browned crumbs.

Method. Take the cauliflower, cut off the stalk and trim off all except about four or five green leaves. Put the cauliflower to soak in cold salt water. Boil till it is tender, but not broken in boiling salt water. It will take about twenty to thirty minutes according to the size. Keep it well skimmed. Lift it out carefully, and well drain off the water. Put it on a hot dish and squeeze it lightly together with the hands and a clean cloth. This compresses it and improves the shape. The sauce should be made while the vegetable is being boiled. Melt the butter in a stewpan, stir in the flour smoothly, add the milk, and stir over the fire till it boils and thickens. Season well, and mix in one-half of the cheese. Pour the sauce all over the cauliflower; it should be thick enough to well cover it. Sprinkle the remainder of the cheese and a few browned crumbs on the top. Put it in a quick oven till the cheese is browned, or use a salamander. Serve very hot.

Jerusalem artichokes, vegetable marrow, celery, sea-kale, can all be treated in this way.

Tomatoes à la Savoy

INGREDIENTS. Six tomatoes, four tablespoonfuls of chopped cold veal, two tablespoonfuls of chopped ham, one teaspoonful of chopped parsley, salt and pepper, four tablespoonfuls of mayonnaise sauce.

Method. The tomatoes should be firm but ripe. Cut out the centre piece at the stalk end; then carefully take out some of the pulp, leaving a hollow in which to put the stuffing. Mix together the chopped veal, ham, and parsley; season it carefully, add enough mayonnaise sauce to well moisten the mixture, and fill the tomatoes with it. Place each tomato on a neatly-cut piece of fried bread. Garnish them with a little lettuce, and serve them as cold as possible.

Curried Mushrooms

INGREDIENTS. One dozen large mushrooms, one ounce of dripping, one onion, three teaspoonfuls of curry powder, one teaspoonful of curry paste, one teaspoonful of flour, one pint of stock, a little lemon juice.

Method. Peel and carefully examine the mushrooms. Melt the dripping in a pan, peel and slice the onion, and fry it a pale brown; then put in the curry powder, paste, and flour. Let these fry gently for a few minutes, then pour in the stock and stir over the fire till the sauce boils; season it carefully. Next put in the mushrooms, and let them simmer very gently for about half an hour, or till they feel tender. Put them in a hot dish, and arrange a border of nicely-boiled rice round. About four ounces of rice should be thrown into a pan of fast boiling salted water, and boiled till tender; it should then be drained off, well washed under the cold water tap to separate the grains, and dried in the oven.

Celery Fritters

INGREDIENTS. Three heads of celery, a quarter of a pound of flour, a quarter of a teaspoonful of salt, a quarter of a pint of tepid water, one tablespoonful of melted dripping, the whites of two eggs.

Method. Sieve the salt and flour into a basin, stir into it smoothly the dripping and water. Beat the whites of eggs to a very stiff froth, then add them very lightly to the batter. Wash the celery, cut off the outside sticks, cut the white sticks into pieces about four inches long. Let them cook gently in a pan of hot, salted water till they are just tender. Then drain them, and dry them gently with a cloth. Have ready a pan of deep frying fat, drop a stick of celery into the batter, then into the frying fat, and fry it a pretty brown; drain it well on paper. When all are fried, pile them up in a hot vegetable dish,

Salsify may be treated in the same way. Brussels sprouts are very good dipped in batter and fried.

Asparagus with Vinaigrette Sauce

INGREDIENTS. A bundle of asparagus, three tablespoonfuls of salad oil, one tablespoonful of tarragon vinegar, half a teaspoonful of chili vinegar, one teaspoonful of chopped tarragon, one teaspoonful of chopped chervil, salt and pepper.

Method. Trim, wash and slightly scrape the asparagus, cutting the sticks the same length. Tie it in small bundles, put them in a pan of boiling salted water, and boil them gently until they are tender. Then lift them out carefully, drain them well, and arrange the heads neatly on a slice of hot buttered toast. Put all the other ingredients into a basin and mix them well together. Season this sauce carefully, pour it into a sauce-boat, and serve it with the asparagus.

Stuffed Vegetable Marrow

INGREDIENTS. One small marrow, two ounces of breadcrumbs, two ounces of butter or clarified fat, four ounces of cold meat or poultry, two teaspoonfuls of chopped parsley, one teaspoonful of chopped shallot, one teaspoonful of chopped mixed herbs, two teaspoonfuls of white sauce or milk, one egg.

Method. Peel the marrow, and cut it in half lengthways. Scrape out all the seeds and soft, woolly part. Chop the meat finely, mix with it the parsley, shallot, herbs, crumbs, seasoning, and melted butter, and then beat the egg and add it also. If the mixture seems dry, add the sauce, but it may not be necessary. Fill each half of the marrow with this mixture. Put the halves together, and tie them in place with a piece of broad tape, then wrap it up in a piece of buttered paper. Put the marrow in a saucepan with water to come about three-quarters up the marrow. Let it boil gently till it feels tender when pierced by a skewer. It will probably take half an hour. Place it on a hot dish and serve with it tomato or brown sauce.

Cucumbers are excellent done in this way.

Braised Carrots

INGREDIENTS. Two bundles of young carrots, two ounces of butter, one pint of good brown stock.

Method. Peel and trim the carrots, put them in a saucepan with cold water and a pinch of salt. Bring the water to the boil, then strain if off and dry the carrots. Melt the butter in a saucepan, put in the carrots, and fry them a nice golden brown. Then add a quarter of the stock, put a piece of buttered paper over the top, then the lid, and let them braise slowly at the side of the fire for an hour or more. As the stock becomes less, add more until you have used the pint. When the carrots are done, the gravy should look nice and thick, like glaze. Put the carrots in a hot dish, and pour the gravy over. It should first be nicely seasoned, and if it seems too firm, add a little more stock to it.

Vegetable Scallops

INGREDIENTS. Four Spanish onions, one pound of tomatoes, two ounces of butter, browned crumbs, salt and pepper.

Method. Thickly butter some scallop shells, either the natural ones, or those of tin or fire-proof ware. Sprinkle them thickly with bread-crumbs. Boil the onions till soft, then cut them in thin slices; slice the tomatoes as well. In each shell put a layer of onions, then one of tomatoes, another of crumbs with a dust of salt and pepper, and so on till the shells are full. They should be slightly heaped up with the last layer of crumbs. Put a few tiny bits of butter here and there on each. Bake them in a moderate oven till they are a nice brown and hot through. They will probably take a quarter of an hour. Onions alone, or vegetable marrow make excellent scallops.

Spinach à la Carlton

INGREDIENTS. Two pounds of spinach, one pound of potatoes, two ounces of butter, one pint of tomato sauce, two ounces of dripping.

Method. Wash and peel the potatoes, then cut them in halves lengthways. Put them on a baking tin with two ounces of beef dripping; put them in the oven, and bake them till they are soft and nicely browned. Wash and pick the spinach very carefully; it should be washed in several waters, otherwise it will be gritty. Put it in a large saucepan, with half a pint of boiling water, a tablespoonful of salt, and a tiny piece of soda. Press it down well with a wooden spoon, and let it boil fast, stirring it often to prevent it sticking. Let it cook till it is soft, then drain it in a colander, pressing it well. Next either rub it through a sieve or chop it very finely. Melt the butter in a stewpan, put in the spinach and salt and pepper to taste, make it thoroughly hot, then arrange it in a bed down the centre of a hot dish. Arrange the baked potatoes in a line down the middle, the pieces overlapping one another. Pour the tomato sauce round. For the recipe, see under SAUCES.

Jerusalem Artichokes à la Crème

INGREDIENTS. Two pounds or less of Jerusalem artichokes, milk and water in equal proportions to cover them. For the Sauce: One pint of milk, one small carrot, one stick of celery, one gill of cream, one bay leaf, one shallot or onion, two ounces of butter, one and a half ounces of flour, ten peppercorns, salt and pepper to taste.

Method. Cut the carrot, onion, and celery into dice. Put them in a saucepan with the milk, peppercorns and bay leaf, and let them simmer for a few minutes. Mix the flour and butter together, strain in the milk, then stir over the fire for about ten minutes. Season it, add the cream, and it is ready. Now prepare the artichokes. Well wash and peel them, dry and cut them into neat, pear-like shapes. Put them into the pan containing the milk and water and a teaspoonful of salt for each quart of liquid, and boil until quite tender for about half an hour. Then drain them, arrange them on a hot dish and pour over the sauce.

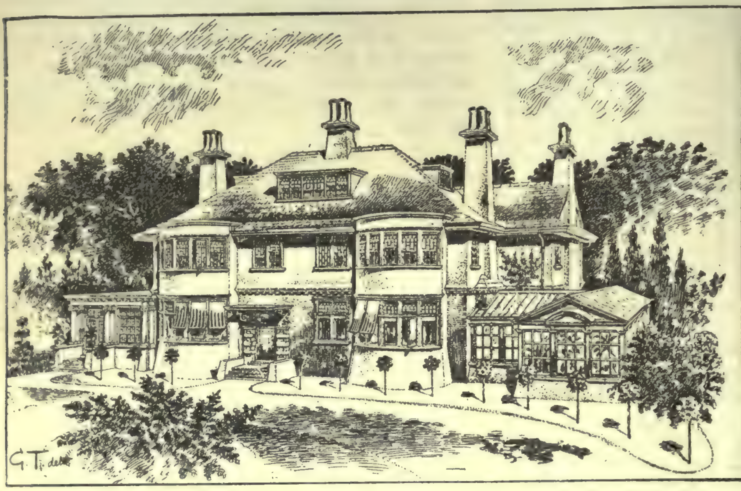
Continued

continued from page 2036

ARCHITECTURAL DESIGN

Typical Designs. Designing Elevations. Classic Renaissance. Studying and Evolving Styles. Proportions. The Five Orders of Architecture

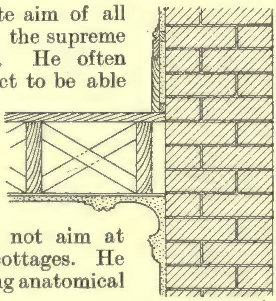
By GASPARD TOURNIER



3. ELEVATIONS TO FIGURE 2 (Messrs. Rolfe & Matthews, Architects)

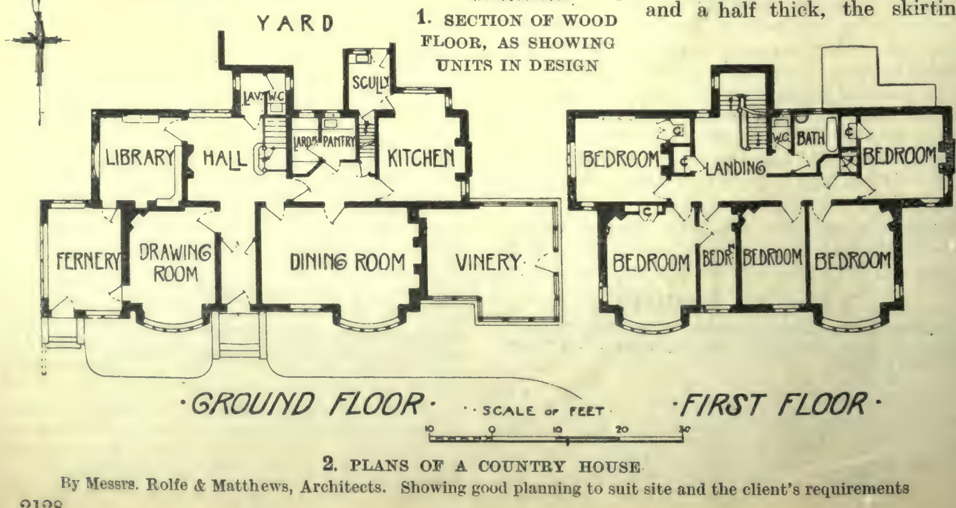
WE now come to the ultimate aim of all the student's endeavours, the supreme subject of architectural design. He often asks at what stage he may expect to be able to start designing for himself. This is a most important matter. He must attack it by *system* or he will waste much time and be disheartened by many humiliating failures. He must begin early, but he must not aim at palaces, nor even at cottages. He must begin with designing anatomical parts only and not wholes; and these at first must be of the simplest constructional description.

The bodies of animals have certain members common to all of them, each bearing a certain relationship to the other, such as arms, hands, eyes, ears. Similarly, buildings have common parts—rooms, corridors, walls, and windows. They vary in design, just as the limbs of animals do, but repeat elements common to all. These elements must be tackled as "designs."



1. SECTION OF WOOD FLOOR, AS SHOWING UNITS IN DESIGN

For instance, let us start with designing an ordinary and quite simple wood floor and its junction to the wall [1]. Put aside all books and drawings dealing with the subject, and set down the provisions, or what would, in the case of an author, be the information to be embodied in a sentence he wishes to write, including the spelling of the words. Suppose the joists to be, say, 9 in. by 2 in. and 1 foot apart, the floor board $1\frac{1}{4}$ in. thick, the walls one brick and a half thick, the skirting

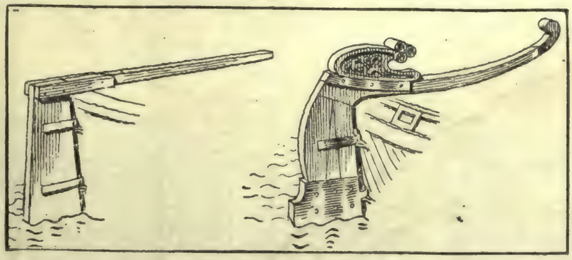


2. PLANS OF A COUNTRY HOUSE
By Messrs. Rolfe & Matthews, Architects. Showing good planning to suit site and the client's requirements

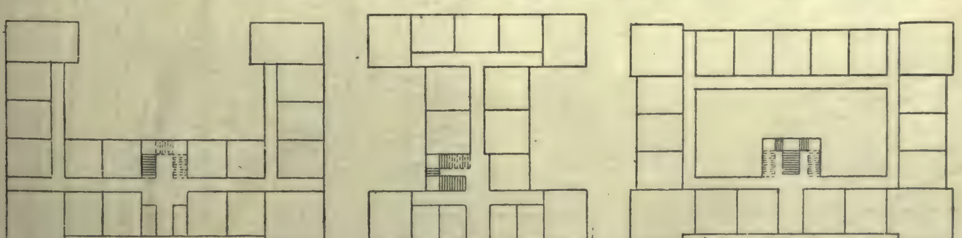
8. PROPOSED WESLEYAN HALL AND OFFICES, WESTMINSTER
Messrs. Lanchester & Rickards, Architects

for room above to be 11 in. and the cornice for room below to be 18 in. in girth, which means that amount in length of a flexible tape laid across the mouldings, to touch and include their entire section.

A Typical Design. Then combine these details in your scaled section across the floor and you have, in a primitive way, two items of personal designing as such. These are the mouldings to the skirting and the cornice. The purpose of such mouldings is to give shaded lines to the eye to emphasise or soften edges or borders, or skeleton lines, some lines to show up strong or black by being well cut in and angular, others blending lighter above or below by curving the section of the mould. In the case of the skirting the moulding lines suggest a tapering back



9 AND 10. TWO RUDDERS ILLUSTRATING THE DIFFERENCE BETWEEN UTILITY AND ARTISTIC FITNESS IN DESIGN



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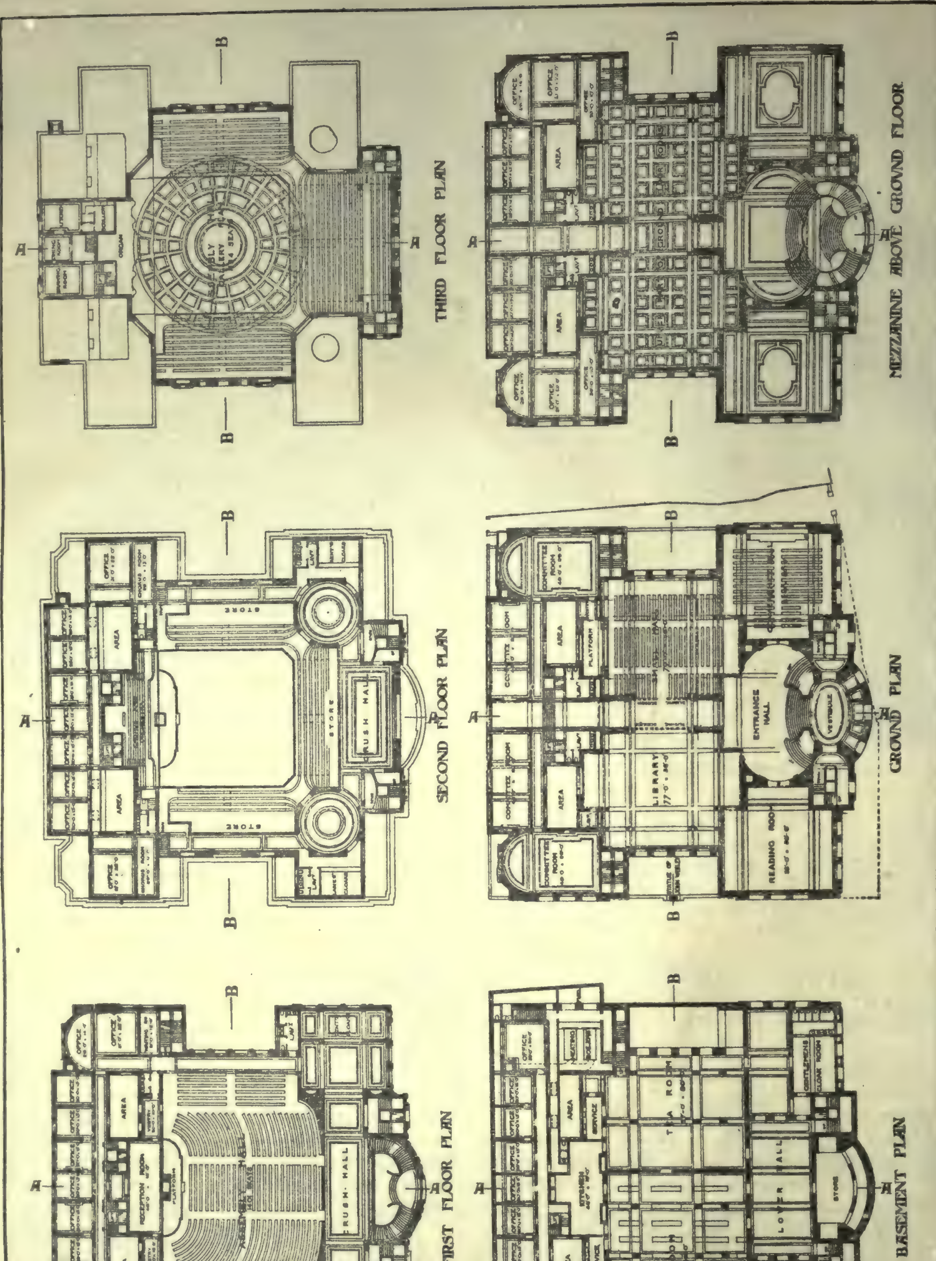
BLOCK PLANS SHOWING METHODS FOLLOWED FOR INCREASING COASTAGE FOR LIGHT BY WINGS AND COURT AREAS



7. PLANS OF PROPOSED WESLEYAN HALL AND OFFICES, WESTMINSTER

Messrs. Lanchester and Rickards, Architects. Showing a fine example of complex planning solved with lucid simplicity

towards the wall. You remember that the wider a board the more it is liable to shrink with time, so you keep within moderation by using two boards, which you join by a groove and tongue and emphasise the fact by another facial moulding, or by a simple set back as shown in this case. In the cornice to the ceiling, keeping in mind what has been said about mouldings,

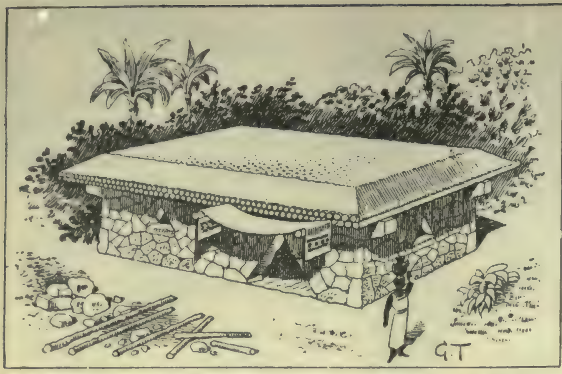
12. PART OF PROPOSED UNIVERSITY FOR SOUTH WALES
W. B. Caröe, M.A., Architect. A striking example of free adaptation in style

you probably elect to use them in the fashion of a cove to soften the transit from the vertical wall to the horizontal ceiling, which is the method in general use. But, in time, you become fastidious about cornices and their relative proportions to the rest of a room, and find many other ways of making a cornice harmonise with the character of the room.

In this way you attack all the anatomical members of a building, and it will be seen you have before you a large task which must be done concurrently with other studies. From it you will come out equipped for designing complete combinations, and you will see by it that the elevations must be governed by the plans and sections—not vice versâ, as many, at an early stage, are tempted to do. The plans and sections represent the skeleton, and the elevations, skin or clothing. If an artist designed an animal without reference to its bones, a monstrosity would result; so a good plan is always capable of having good elevations evolved from it.

11. AN INTERIOR ARCADED CORRIDOR
Referring to the difference between the legitimate and illegitimate transference of features from one style of architecture into another

A Good Plan. The merits of a plan are judged by the extent to which the position of every detail meets the requirements of the people who are to inhabit the dwelling. For instance, a drawing-room should be on the sunny side of the house, its doors not too near the fireplace so as to disturb those sitting round the fire, and a kitchen should have its windows looking northwards. The range should not be placed so that the cook has to stand with her back to the fire, etc. Corridors should not be wasteful in length or wind indirectly to rooms, and so on. The functions of each member must be grasped before trying to solve the problem of



13. TYPE OF STONE BUILDING IN THE PRIMITIVE AGES

their union. This the student at first generally thinks he can do by seeking, in books and the back numbers of the architectural publications, a plan answering the requirements of the one he is making. He then tries, by slight alterations, to preserve its points yet hide its origin. This never can be done. For instance, 2 and 3 show a country house at Tamworth designed by Messrs. Rolfe & Matthews, architects. The plans are admirably contrived to suit the site and the requirements of the client. Let the student, with tracing-paper experiment by moving the rooms about, not even disguising the original plan, and the whole will be thrown into bad planning.

This is altogether different from critically analysing the plans of others till they become digested in one's mind. Such study is very helpful; but when one plans for oneself, one must rely solely on the degree of inventive power already attained

A good method for beginners is to draw separately to scale each room required to be incorporated in the plan, then to cut these out and use them as dominoes, moving them about till a likely combination is found.

The Problem of Light. A building can get light on one or more of its sides according to the restrictions round the boundary of the site. In large structures, such as municipal buildings, colleges, etc., the amount of available light from the outer boundaries is often not enough. So the coastage for light has to be increased by various sorts of wings, as in **4** and **5**, or by enclosed area courts, as in **6**, or by combinations of wings and courts. In these the problem is so to work things that the strips of rooms have sequence and are connected in groups according to their uses; the corridors to them must not be twisted, but lead people direct, in a self-evident manner, from one part of the building to another.

The houses best planned are those which anyone can picture mentally on entering them. This remark applies to all buildings except sometimes Gothic churches, monasteries, and quaint family houses where the charm of mystery and surprises claim legitimate play. But these, when well done, appear on paper also to "occur" in an obviously natural way. All good plans look simple when they are done—so simple that the tyro thinks them so self-evident as to require very little ingenuity to make; but he soon finds out his mistake when he tries for himself and sees how necessary it is for him to "grow at it" slowly.

A striking example of extremely difficult planning, solved in a masterly and therefore apparently simple way, is Messrs. Lanchester & Rickards's Wesleyan Central House, recently won in a competition [**7** and **8**].

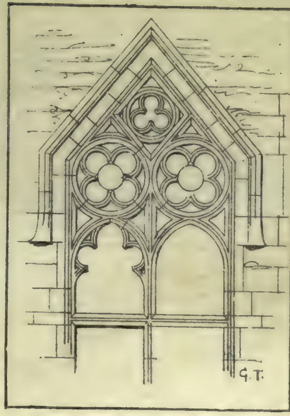
On a relatively cramped site there had to be fitted in features to meet several very opposite needs, yet the whole had to be treated with spacious dignity, the location of each part being obvious and direct. It is a plan for which no precedents could be consulted; unassisted invention had to do it.

Designing Elevations. After plans come elevations, and here we come to deal with what is more generally called architecture by the outside public, though it is but one of its integral parts. The student designs his elevations and

15. SKETCH OF THE OLD STAIRS AT KING'S SCHOOL, CANTERBURY

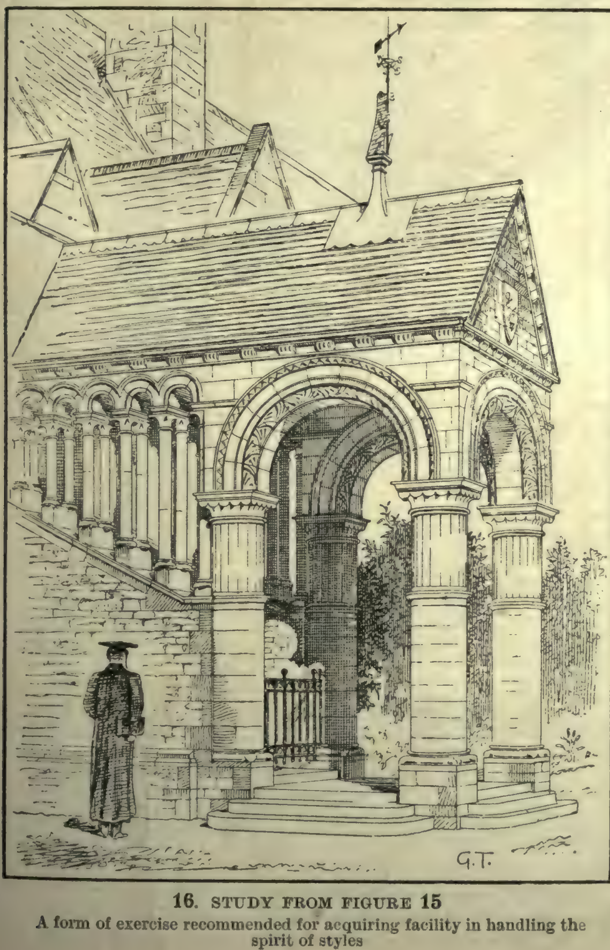
his first attempts invariably end in his critics saying they are ugly and have no "style." He has read what the textbooks say on "style" and "beauty" in design, and usually considers he has fulfilled their directions. He therefore cannot perceive the reason his achievements do not please.

For instance, he has seen the statement urged that a utilitarian origin accounts for everything ever shaped by man, and that absolute fitness for its practical purpose gives tone, "style," and makes it beautiful. This principle is sound in germ but it is only a factor in the equation. A modern steam-locomotive is a masterpiece of fitness, in every detail, for the practical purposes attained, yet no amount of reasoning can make us think it is anything but ugly; and no one without an effort of supreme verbal gymnastics, such as Rudyard Kipling has achieved, can make poetry out of its physiognomy. Take a wooden rudder, design it with practical common-sense, and you have **9**. The thing does not give pleasure to look at, and is especially offensive at the junction of the rudder with the tiller, yet the junction is theoretically correct. Compare it with that of a Dutch rudder [**10**], and it cannot stand the same theoretical test, yet it pleases and gives us a sense of being suitable. The fact is that in æsthetics—"the science of the beautiful"—there have to be compromises between the various elements; and these are many.



14. EXAMPLE OF THE "ANGULAR ARCH" TRANSMUTED INTO GOTHIC

Illogical shapes sometimes please in art, and this is often due to the fact that a silly object perpetuated by one generation becomes beautiful by the memorised associations connected with it gathered in the hearts of the next generation.



16. STUDY FROM FIGURE **15**

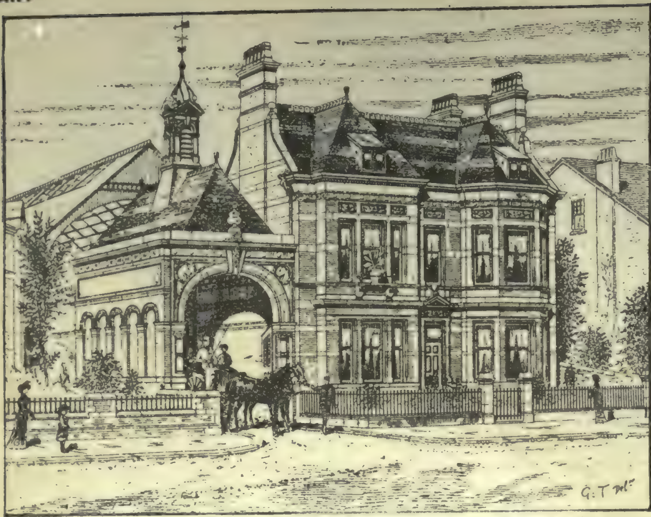
A form of exercise recommended for acquiring facility in handling the spirit of styles

Another dogma in the books is: "Copy Nature in design; if you add, it must be ugly shams and vulgarities—it is as if you 'gilded the lily.'" But man has instinctively, all through the stages of his evolution, universally shown no complete love for the way Nature has designed him. He has always been tinkering to "improve" it or hide his shape—ashamed of it.

Study of Ancient Styles. Ancient fashions do, sometimes, appeal to our æsthetic feelings—such as those of the Greeks and Romans, the Egyptians and Moors, etc., when at their zenith; and it is seen that men, in seeking for what they thought beauty, stamped these experiments in "adornment" with a unity of type in race and period—a unity which persisted in their dress, utensils, and architecture. This unity is what is called a fashion, or manner, or style.

The student, having reviewed these styles, and having seen in all of them some features that look to him beautiful and others vagaries, is at first impressed with a strong desire to *invent* for himself a new style which shall embody the choicest of all of them. But a style cannot be "invented."

The delusion was very rampant in England during a part of the last century, and some of the resultant abortions are to be seen today in the buildings of that time.



17. EXAMPLE OF A BUILDING DEFICIENT IN "STYLE"

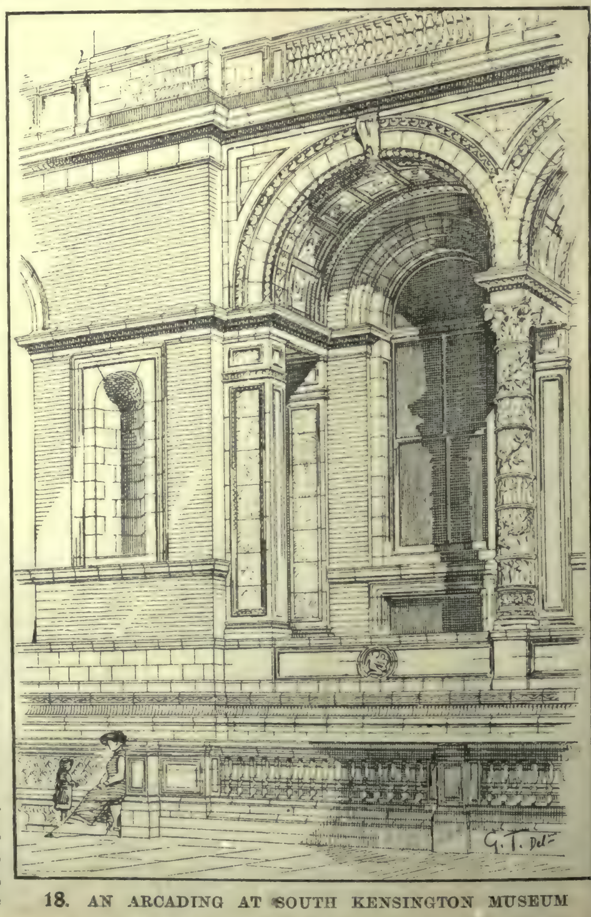
A style is a thing of growth fostered by unanimity of sentiment in a community, and the definitions of what is beautiful have varied therewith.

Having grasped what is meant by styles, and that there can be no such thing as the invention of a new one, the student must select a root style and work from it. Let that root style be that of the trend of his day, and let him put into it all the invention and individual character he has.

Classic Renaissance. The root style of to-day is Classic Renaissance, which has reached us by an evolution ripe with English associations of our past; and it has been wisely said that it is from our past that all beauty comes, whilst that which is sprung on us raw rasps us and makes us dissatisfied. But keeping to a root style does not prevent the admission of constructional or other features new to the style's origin, when these assimilate sympathetically with the root style. It is to the advantage of modern English Renaissance that this is being done in many directions. Consider, for instance, freedom in treating arches and their architraves. Fig. 11 shows an arcading which disregards tradition, but it cannot be said to jar on classic feeling or look incongruous. Among leading masters of English architecture who are more and more abandoning the rigid letter of tradition while retaining the essence of its spirit is Mr. W. D. Caröe, M.A., who has obtained many striking results. One of them is his recent design for South Wales University, where he introduces a row of angular arches [12]. The building is very large, and, seen in conjunction with the whole, the feature is a happy one. Its construction is legitimate. Its origin goes back to the time when primitive tribes first built walled houses [13]. The transmuting of a feature from one style into another has many legitimate precedents. Four of the five orders of columns and entablatures of the Roman style came thus from the Greek, and, during the Gothic revival of last century, though many of its transmutations were painfully raw, many were æsthetically legitimate, such as that shown in 14.

So, style is not bound by a schedule of features, but is a matter of essence or spirit.

Evolving a Style. A practice recommended for beginners studying style is to take an old example, or ruin, as a suggestion for a theme, and



18. AN ARCADING AT SOUTH KENSINGTON MUSEUM

Referring to the question of fixed proportions in architecture

continue its evolution in the spirit of its initial style, but not its letter. Fig. **15** represents the old stairs at King's School, Canterbury. Its style is that which came to England with the Normans, and was derived from the Romans. Fig. **16** shows a free study evolved from its spirit.

Before leaving this subject it should be noted that architects sometimes, in adversely criticising a design, say it has "no style." Strictly speaking, every building has a style or fashion, however objectionable. What they mean by "no style" is that the result gives an effect which (for lack of nearer words) may be said to be sterile and incongruous, as in **17**.

Proportion. Another difficulty the student meets with concerns the functions of proportion. He reads about many arithmetical ratios in the dimensions of features, such as that the height of a window should be twice its width, and that a cornice should be a certain fraction of the height of the column beneath it, etc. He tries to drag these figurings into all he does. The result disappoints him. The fact is that a feature which looks well proportioned in one position does not necessarily do so in another. Proportions must be harmonised with their surroundings. A cornice, for instance, does not primarily claim a ratio to the diameter of the column beneath it, but to conditions above it. The cornice at the South Kensington Museum [**18**] is below the ratio of the standard orders, but it is derived from a minor cornice, or string, brought from the side wings, and supports arches in a way which, when seen associated with the whole design, looks well proportioned. At the Bible Society's house in Queen Victoria Street there is what is technically a cornice to the pilasters [**19**]. This is also art of orthodox ratio ; but the massive pilasters carry the eye past it, up to the higher cornice, with an effect well proportioned.

Five Orders of Architecture. The study of what is known as the Five Orders of Architecture is responsible for much over-use of arithmetical ratios. These orders are of great value in themselves as beautiful types to be well studied, but not as dogmas. On page 2035 will be found reduced copies of the fine set published by Sir William Chambers in his treatise on architecture. They are called, respectively, Tuscan, Doric, Ionic, Corinthian, and Composite. The Doric, Ionic, and Corinthian belonged to Greek architecture ; the Romans transmuted them into their own style, and in time the fifth grew into existence. They became standardised to proportions based on multiples and fractions of the lower diameter of the columns. Half the diameter is called a module, and this is divided into thirty equal parts, called minutes.

19. THE BIBLE SOCIETY'S HOUSE
I'Anson & Son, Architects. A good instance of bold freedom.

Continued

Group 17
APPLIED EDUCATION
4
Continued from page 1946

THE MAN WHO THINKS

Reflection. The Necessity for it. How to Develop the Faculty. The Value of Discussion. Thinking Alone

By HAROLD BEGBIE

TO acquire information is comparatively easy ; to make use of it, which is the real object of learning, is extremely difficult. Many things, as Landor tells us, which were formerly *known* as poisons are now *employed* as drugs. "Perhaps if we should meet Shakespeare," says Emerson, "we should not be conscious of any steep inferiority ; no, but of a great equality—only that he possessed a strange skill of using, of classifying, his facts, which we lacked."

Cramming the Mind. The brain absorbs information as a sponge drinks water. It is possible to fill the brain with knowledge and yet find it sodden, heavy, and useless. Only by reflection upon the information we acquire can the mind make use of knowledge, and employ its facts for creative purposes. There is a digestion and an assimilation of the mind as well as of the body.

In olden days meditation was regarded as a principal exercise of the philosophical life. The prophet went into the wilderness, the ethical teacher sat with folded hands and closed eyes. To be quiet was not then synonymous with idleness. To-day—as may be seen by the questions put before young men in competitive examinations—we prize a mass of information far beyond the power to make use of it. The soldier must give proof of knowledge of mathematics and dead languages, not of his capacity to lead a regiment or conduct a campaign. The civil servant must prove that he has Homer by heart and historical dates by rote, not that he has pondered his knowledge and fitted himself for government.

It is a common remark that to meet a great man is to encounter disappointment. The great soldier proves to be an uninteresting man ; the brilliant philosopher is a dull dog ; the mighty financier a commonplace bore. We miss in our heroes the dash, the vivacity, the forcefulness, and power which we have accustomed ourselves to think about in their connection.

The Successful Man. But the man who succeeds in his work must, almost of necessity, prove socially uninteresting. He can never hope to possess the flourish and animation, the high spirits and the glittering ornamentations of the mediocre person who struts under the canopy of heaven as gay and light-hearted as a cockerel. His success has not been won by sudden rushes and unreasoning intuitions ; his everlasting contributions to the honours and glories of humanity have not been made by impulse and impromptu. Success which has been obtained by such methods seldom stays by humanity.

Almost invariably the leaders of mankind are quiet and drab-coloured persons in the brightness of Vanity Fair. Their success has been won by a continual process of reflection, a perpetual habit of meditation, a process and a habit which cause them at all moments to be self-questioning and self-answering. They have accustomed themselves to absorb the light of the sun, not to reflect the glitter of every rush and taper. Tell a great man some fact of which he is not aware, and instead of answering you with another fact greater than your own, or instead of rushing off to narrate his new-found knowledge to the world, he will ponder it, question it, and in his own gradual fashion so absorb it as to render it useful and homogeneous with other facts already stored for eternity in the treasury of his mind.

Many men had seen an apple fall to the ground, but it was one man who deduced from that commonplace of human experience an eternal and universal law. Many men had seen the lid of a kettle dancing above the pressure of boiling water, but it was one man who built from the commonplace of life the steam-engine which has revolutionised the world.

The Habit of Meditation. Accustom yourself to reflection, and you will almost assuredly be led on to creation. It was because Charles Dickens had acquired the habit of meditating on everything he saw in boyhood that he was forced, despite an unlikely environment and an insufficient education, to create more characters on the canvas of art than any other genius of imagination. Many a man had walked the London streets at night, but it was only Dickens who so absorbed and made his own the tragedy and the comedy of the town as to create in literature a faithful and eternal picture of the scene.

The meditative man is usually the creative man. Inventors are silent men ; great generals are seldom loquacious ; captains of industry are not often chatterboxes. To be always retailing information is not generally to be creating knowledge.

There is an instinct of meditation which is one of the best gifts of the gods, and which is surely never to be learned ; but the habit of reflection, we believe, is one that can be cultivated, and there are exercises to this end which every man, whatsoever his ambition, should of a certainty find time in his life to practise conscientiously. If a man would merely enjoy the experience of his life, it is necessary for him to acquire in some measure the habit of reflection ; but if a man would succeed as an artist, as an inventor, as an artificer, as a teacher, as a

discoverer, or in any of the fields of human activity, it is beyond all things essential to him that he possess in constant energy the habit of meditation.

The Habit of Reflection. The common practice of giving a child a book, and after a page or two has been read questioning its memory thereupon, is an illustration of the signal fashion in which we are thrusting reflection out of employment. One of the best exercises for acquiring the habit of meditation is the method which a wise governess employs with a child ; not questioning it as to details which its memory may or may not have remembered, but rather questioning it as to the effect made upon its mind by the passage lately under its consideration. For while memory is of slow growth, the habit of reflection is instant with every hour in a child's life. Watch a child, and you will perceive it reflecting on everything that enters the field of its vision ; tell it a story, and at every point, by a question or a look, it will inform you that each incident of your narrative has set the machinery of its meditation in motion. It is natural to meditate and reflect ; it is only the insensate habit of cramming with the details of information which, in the case of the multitude of school children, chokes, suffocates, and finally destroys this natural faculty.

For the victim of this unscientific system of education, for the grown man who would fain recapture something of the power of this natural faculty, the path is by no means an easy one. He may even find it painful to think at all, for he will be applying his will to a department of his mental equipment which has almost atrophied. Many men confess that it is irksome, that it irritates them, to think out a problem. In such cases it is necessary to begin at the beginning of all reflection, to return honestly to the experience of a child, and cultivate the habit of wonder.

The Stimulus of Wonder. The earliest exercise of the brain in Nature's process is wonderment. A child accepts nothing without wondering how it comes to be. That a watch should tell the time does not interest it ; it wonders how the wheels go round. It wonders why the stars do not fall, why the waves do not flow over the land, why the flowers have a fragrance. Facts do not interest it ; the existence of the fact is always its wonder. In place, then, of accepting the daily facts of existence as a matter of course, the student must learn to let nothing escape his wonderment. He must begin with the child's mind, and wander in the field of Nature. He will soon be astonished to find that his easy-going ignorance has dulled his senses so completely as to make the great fairyland of Nature a stupid and unsuggestive place. Life will become a keener pleasure to him ; his wits will waken from their slumber ; he will be more and more puzzled, but always more and more delighted. So long as one accepts life as a dull and necessitous fact, existence can never stimulate the constructive faculties of the intelligence. Begin to wonder, and you begin to think.

Research. The second exercise flows naturally out from the first. Directly a mind has begun to wonder about Nature, directly it has perceived that life is a constant presentment of mystery, it becomes eager for an explanation of its problems. The mystery teases it into search after reasons. The least scholarly of men, when once they have perceived intelligently a problem in Nature, become students of knowledge. It is a healthy instinct that leads us to seek after reasons and explanations, and we must be guided by it. The habit of consulting encyclopædias is one that leads infinitely farther than to the gratification of curiosity—it leads the way to reflection, which is the beginning of creation. A man who has found a pleasure in seeking for explanations of all those phenomena which stir his wonderment is not likely to remain a seeker after facts ; he will proceed to a comparison of his discoveries with men of like taste ; he will think about them, turn them over in his mind, read about them, talk about them.

Discussion. The value of conversation with men of intelligence is hardly to be exaggerated. The spoken word is more impressive and suggestive than the written word ; the mind is more detached in conversation, is more ready to seize upon a point, to apprehend an argument, to perceive the drift of a thesis. Moreover, it can question as it goes, and needs to skip no difficult passage. In olden days, men learned their philosophy by word of mouth, and students were *talked* into pedagogues. A good conversation is better than a treatise. Speech, it has been said, is the electricity of action. He is a wise man who seeks a *viva voce* with his intellectual superiors, and considers no day a good day in which he has not enjoyed the felicities of conversation. A man discovers in conversation exactly how much of the information he thinks he has acquired is really his own, has really been apprehended, really grasped and absorbed. Without these constant discussions, no man can truthfully determine how surely he is laying the foundations of his knowledge. And conversation is not only a test of our studies, it is a tonic to our energies. It inspires us with fresh relish for the intellectual life, and breathes into our spirit the quickening impulse of spiritual curiosity.

Privacy. Finally, we come to the environment necessary for the exercise of the faculty of reflection. It is now impossible for a man to go into the wilderness. We cannot commonly follow even Thoreau into the woods, who went there "to live deliberately, to front only the essential facts of life, and see if I could not learn what it had to teach, and not, when I came to die, discover that I had not lived."

But even more necessary than in older and quieter periods is now the opportunity for reflection. The wise student will set apart a certain time in his day when he may escape the contagion of our rushing age and be alone with his mind. He will insist upon giving himself an intellectual self-examination as severe and earnest as the spiritual self-examination enjoined by religion.

Not how he stands with God, not how his soul grows in relation to spiritual reality ; but how much he honestly knows of the world about him, how truthfully he has understood his readings and his conversations, and how far he is advancing as a master of his craft. It is the experience of ages that profound reflection is difficult in an environment where distraction easily enters. The severest of chambers is necessary, and even there the ancient habit of closed eyes may be found a necessity. Few people realise, perhaps, how hard a thing it is to pursue a single line of thought without breaking away into a hundred aimless directions. It requires considerable concentration of the will-power, even in places of the greatest solitude, to follow steadily and consecutively the thread of a single thought. Only with difficulty will the student learn so to conduct his self-examination that his reflections are undistracted by valueless and wandering thoughts. Montaigne once determined, "solitarily and quietly," to wear out the remainder of his life ; but he found that his spirit warred against this seclusion, begetting in his mind "chimeraes and fantisticall monsters, so orderlesse, and without any reason, one huddling upon another, that at leasure to view the foolishnesse and monstrous strangenesse of them I have begun to keep a register of them.

To sum up, the exercises for the creation of the reflective habit are : first, an intelligent response to the wonderment of Nature ; second, a search for explanations and reasons ; third, a cultivation of conversation with intellectual superiors ; and fourth, a recognition of the sanctity of privacy.

Practical Results. Most people, says a writer, are other people To be oneself, to be greatly individual, to be sincerely and splendidly self-conscious, one must be given to meditation. "I have more understanding than all my teachers, for their testimonies are my meditations." By continual reflection upon what we observe, and what we hear and what we see, we grow to perceive the real meaning of these things, and from this apprehension—far rarer than many people imagine—we go on to creation. No man can apply his education who has not digested and assimilated it as he goes along. You may know all the volumes of this present work by heart, but if you don't give a certain time of your day to discussing them, and to reflecting upon them in your own privacy, you will fail to win from your knowledge the pleasures and rewards of certain success. An engineer may rise from the lowest position to the highest, may have had a lifelong experience of all the various "shops" in a factory; but if he has not reflected upon the working of the machines, has not meditated upon the system of the operations, he will never be able to suggest an improvement in the machinery, nor ever be able to invent a new method or a new article. If we would apply our knowledge, we must certainly reflect upon it.

The Student's Bible. In one of his letters Matthew Arnold writes : "I read five pages of Greek anthology every day, looking out all the words I do not know ; this is what I shall always understand by *Education*, and it does me good, and gives me great pleasure."

The student can begin his work with no better aid than a really good dictionary. He should strive to possess himself of "The Century Dictionary" and Professor Wright's marvellous "English Dialect Dictionary." The dictionary, indeed, is the Scholar's Bible. It must be always at his elbow. The habit of looking up a word is an excellent one, not only good in itself, but good in that it springs from the other habit of reflection. To see a word of which we know not the meaning ought to drive the stupidest to his dictionary ; but to see a word the meaning of which we know very well but whose history we are unacquainted with ought also to send us to the dictionary. The history of words is one of the pleasantest studies in life, and the reflecting man will always be finding in his reading words which check him and puzzle him with their origin.

To take a trite but striking instance. Everybody knows what it means to say that a man is *ostracised ;* but how many men know the inner, the reflective meaning of that word ? A man with a smattering of Greek will say that it has something to do with an oyster shell, and leave it at that, sufficiently puzzled. The true student, the deeply reflecting man, will hunt down the word till he has found how the Greeks recorded their votes on oyster shells, and learnt from his search into the meaning of this single word something of the history of a whole people. Looking up words is a great education ; and the more the habit of reflection is encouraged the more frequently will the student consult his dictionary. It is the habit of reflection, in short, which determines a man to find out a reason for everything, from a word to a law in Nature.

Continued

EIGHTEENTH CENTURY PROSE

3. In which the Review of this Period is Concluded. Notes on the Study of Style, Letter-writing, and the significance of "A Man of Letters"

Continued from page 2055

By J. A. HAMMERTON

WE have now learned enough to realise that the study of English prose must be pursued on lines different from those on which we undertook the study of English poetry; whereas poetry is universally the voice of inspiration, prose in its development departs from the sphere of literature proper. Sometimes retaining but frequently losing its claim as literature, it becomes in turn the servant of theology, the handmaid of history, the medium of science, the channel of philosophy—essential alike to religious and atheistical propaganda, to practical and to theoretical ends.

A Parting of the Ways. At the beginning of the eighteenth century the student stands at a parting of the ways. He has to distinguish between what is prose literature and what is not. To a certain extent the answer will depend upon his own bent or "humour." But he still has to ascertain why and when and by whom particular books were written. He must learn not only the history of those books, but become acquainted with their relationships—their position in regard to the treatment by others of the subjects with which they deal—before he is able to satisfy himself as to their value. A French book of scientific, theological, historical, or philosophical importance is usually of literary importance also. The rule in France is, however, the exception in England.

Turning aside for a moment from our historical review of the literature of this period, to take stock of what we have learned thus far, we must urge the advisability of some study of the political and social developments of which particular books were either a cause or an outcome. The extent of this study will depend largely upon the student's desire to confine himself to or to range beyond the scope of "belles-lettres." By "belles-lettres" is meant literature that is distinguished by the charm of its style or form apart from its claims as a vehicle of instruction. It has to be borne in mind in this connection that in the last result prose lives because of its power not its prettiness.

The Secret of Style. Charm and distinction of style are peculiarly characteristic of our eighteenth-century prose. The century "found English prose antiquated, amorphous, without a standard of form; it left it a finished thing, the completed body for which," as Mr. Gosse says, "subsequent ages could do no more than weave successive robes of ornament and fashion." Style, however, implies something more than precision of form. Good style is inseparable from appropriateness of diction. For example, the great writer does not approach great themes with a string of light colloquial sentences, any more than one would appear at a funeral attired in fancy dress. To appreciate style one must bring to it a knowledge of grammatical rules. But grammar is not all. Ideas are not all. The secret of style lies in the character of the man behind the writing. For this reason, while we can but admire the finished grace of a Chesterfield, Johnson, with all his heaviness, compels our affection.

Eighteenth Century Characteristics. The wider our knowledge of the literature of this period grows, the clearer shall we see the injustice of the common indictment of the age as one of shams and sentiment. Apart from the influence of Johnson, the age of Berkeley and Wesley and Whitefield cannot truthfully be described as devoid of healthy enthusiasm or activity. It was the age of our great historians. It was adorned by some of our greatest philosophers and keenest critics. If it questioned the bases of religion, it quickened both faith and good works. English writers of the period influenced Continental thought more perhaps than did the writers of any other period of our history. Eighteenth-century England, as we have already seen, discovered Shakespeare before the Germans. It standardised the essay, sowed the seeds of modern nature study and modern chemistry, gave birth to our first great novel, laid the foundations of our periodical literature, stood sponsor to the beginnings of daily journalism, and crushed the system of literary patronage. It was the age also of political economy and of public eloquence.

Chesterfield's "Letters to His Son." The eighteenth century is also rich in its letters. The correspondence of Horace Walpole has been already referred to. PHILIP DORMER STANHOPE, Fourth Earl of Chesterfield (b. 1694; d. 1773), was a statesman and wit who is remembered to-day chiefly for his "Letters to His Son." Given to the world in 1774 by the son's widow, these letters were described by Johnson as displaying the morals of a courtesan and the manners of a dancing-master. They argue, nevertheless, despite their worldliness, a sincere solicitude for the welfare of the son to whom they were addressed. A great French critic, Sainte-Beuve, has said of them: "If Horace had a son I imagine that he would address him in this way, and no other." Here is a representative example of Chesterfield's style:

"Style is the dress of thoughts; and let them be ever so just, if your style is homely, coarse, and vulgar, they will appear to as much disadvantage, and be as ill-received as your person, though ever so well proportioned, would, if

dressed in rags, dirt, and tatters. It is not every understanding that can judge of matter, but every ear can and does judge more or less of style; and were I either to speak or write to the public, I should prefer moderate matter, adorned with all the beauties and elegancies of style, to the strongest matter in the world, ill-worded and ill-delivered. . . . A person in the House of Commons, speaking two years ago upon naval affairs, asserted that we had then the finest navy *upon the face of the earth.* This happy mixture of blunder and vulgarism, you may easily imagine, was matter of immediate ridicule; but I can assure you that it continues so still, and will be remembered as long as he lives and speaks. Another, speaking in defence of a gentleman upon whom a censure was moved, happily said that he thought that gentleman was more *liable* to be thanked and rewarded than censured. You know, I presume, that *liable* can never be used in a good sense.

"You have with you three or four of the best English authors, Dryden, Atterbury, and Swift; read them with the utmost care, and with a particular view to their language, and they may possibly correct that curious infelicity of diction which you acquired at Westminster. . . . . Cicero says, very truly, that it is glorious to excel other men in that very article, in which men excel brutes, speech. . . . Gain the heart or you gain nothing; the eyes and the ears are the only road to the heart. Merit and knowledge will not gain hearts, though they will secure them when gained. . . . If you have not a graceful address, liberal and engaging manners, a prepossessing air, and a good degree of eloquence in speaking and writing, you will be nobody, but will have the daily mortification of seeing people with not one-tenth of your merit or knowledge, get the start of you and disgrace you both in company and in business."

Chesterfield's Style. Much might be written of the argument set forth in the foregoing extract. It is quoted for its own sake, but the passage is given also as an example of writing that is at once clear, simple, forcible, and polished. The aim of the writer is apparent throughout. The means he adopts to further that aim are direct. He describes things that are desirable and against them sets the means by which they are to be attained. The chance that ambition may not be sufficiently stimulated is provided for by the closing appeal to fear—the fear of ridicule. Lord Chesterfield uses the words "happy" and "happily" in the now obsolete sense of "accidental" and "accidentally."

Johnson's Famous Letter. By way of contrast to Chesterfield's appeal to selfish instincts may be given part of the famous letter in which Johnson repudiated the patronage which, though it was offered when his "Dictionary" was completed, was—possibly through the indiscretion of a servant—refused when that work was originally planned. Johnson's letter was written after the appearance, in a periodical called "The World," of two papers by Lord Chesterfield recommending the Dictionary to the public.

"Seven years, my Lord," wrote Johnson in 1755, "have now passed since I waited in your outward rooms, or was repulsed from your door; during which time I have been pushing on my work through difficulties, of which it is useless to complain, and have brought it at last to the verge of publication without one act of assistance, one word of encouragement, or one smile of favour. Such treatment I did not expect, for I never had a Patron before."

Johnson, it should be explained, had inscribed the "Plan" of his Dictionary to Lord Chesterfield after some intimation had reached him indicating that that nobleman was interested in the project. His letter continues:

"Is not a Patron, my Lord, one who looks with unconcern on a man struggling for life in the water, and, when he has reached ground, encumbers him with help? The notice which you have been pleased to take of my labours, had it been early, had been kind; but it has been delayed till I am indifferent, and cannot enjoy it; till I am known and do not want it. I hope it is no very cynical asperity not to confess obligations where no benefit has been received, or to be unwilling that the Publick should consider me as owing that to a Patron which Providence has enabled me to do for myself."

Lord Chesterfield, to show that his withers were unwrung, laid this letter open upon his table for others to see. Johnson, pressed for a copy of it, continually refused to give one, remarking on one occasion: "No, sir; I have hurt the dog too much already." Johnson saw through the veneer of Lord Chesterfield's bearing the shrivelling heart of a bitterly disappointed man.

Other Letter-writers. Among other letter-writers of the eighteenth century must be named the poets COWPER and GRAY. The letters of Cowper afford, perhaps, the best argument against the effectiveness of ornamental diction when it is confronted with a style that is simple and sincere. Cowper's delightful letters describe in the most natural and most charming of language the surroundings and incidents of the poet's life at Olney and Weston. Gray's letters possess the qualities of the bookman and the scholar, and represent a man who seems never to have permitted himself to appear in "dressing gown and slippers." The "Letters" of LADY MARY WORTLEY MONTAGU (b. 1689; d. 1762), describe in the simple and elegant style of an accomplished if worldly woman her experiences of travel in Europe and the Near East between 1716 and 1718. Though circulated in MS. during her lifetime they were not printed until a year after her death. The "Natural History of Selborne," by GILBERT WHITE (b. 1720; d. 1793), marks the beginning of popular Nature studies. It is composed of letters to the writer's friends, written, it is believed, at the suggestion of the Hon. DAINES BARRINGTON (b. 1727; d. 1800), who was an antiquary and a naturalist as well as a lawyer.

THOMAS PENNANT (b. 1726; d. 1798) was another famous naturalist and a friend of Gilbert White; his "British Zoology" and "History of Quadrupeds" were for a long time classics of their kind, while his "Tour in Scotland" had an appreciable effect in stimulating travel in that country. The letters of HUMPHREY PRIDEAUX, Dean of Norwich (b. 1648; d. 1724), give many details of old Oxford life.

Various Writers of the Period. Among the divines whose work continues to be read may be named WILLIAM WARBURTON, Bishop of Gloucester (b. 1698; d. 1779), author of a voluminous work entitled "The Divine Legation of Moses Demonstrated." Warburton was a friend of Pope, and a man who, said Dr. Johnson, "Praised me, sir, when praise was of value to me." RICHARD HURD, Bishop of Worcester (b. 1720; d. 1808), was a pupil and biographer of Warburton. Dr. GEORGE CAMPBELL (b. 1719; d. 1796) wrote a valuable "Philosophy of Rhetoric," which is remembered where the "Lectures" of HUGH BLAIR (b. 1718; d. 1800) are rather ungenerously ignored. WILLIAM PALEY (b. 1743; d. 1805) wrote lucidly on the subject of Christian evidence. His "Treatise on Natural Theology" and "View of the Evidences of Christianity" are still read; but his "Horæ Paulinæ," a defence of the genuineness of St. Paul's Epistles, is his most important work. An interesting controversy was raised by the coarse satire of "The Fable of the Bees," a work of doggerel verse and prose commentary in which BERNARD DE MANDEVILLE (b. 1670; d. 1733) ridiculed humanity with none of the moral fervour, but all the savage contempt of Swift.

The butt of Mandeville's personal gibes was Lord Shaftesbury; he was attacked in turn by Bishop Berkeley (already mentioned) and WILLIAM LAW (b. 1687; d. 1761), whose "Serious Call to a Devout and Holy Life" influenced men so dissimilar as Johnson, Wesley, and Keble, and stands by the side of Jeremy Taylor's "Rule and Exercises of Holy Living" as one of the most impressive devotional treatises in the language. The principal Deists of the period, who denied revelation and traced their freethinking parentage to Lord Herbert of Cherbury, were MATTHEW TINDAL (b. 1653 (?); d. 1733), JOHN TOLAND (b. 1670; d. 1722), ANTHONY COLLINS (b. 1676; d. 1729), and WILLIAM WOLLASTON (b. 1660; d. 1724). The Rev. CONYERS MIDDLETON (b. 1683; d. 1750) wrote a "Life of Cicero" (largely a plagiarism) and a remarkably rationalistic "Free Inquiry into the Miraculous Powers which were supposed to have existed in the Christian Church." His vigorous, direct style has many admirers. The "History of Civil Society," by Dr. ADAM FERGUSON (b. 1724; d. 1816), has been ranked as a companion to Adam Smith's "Wealth of Nations." THOMAS REID (b. 1710; d. 1796) wrote "An Inquiry into the Human Mind on the Principles of Common Sense." He had a distinguished follower in DUGALD STEWART (b. 1753; d. 1828). Dr. RICHARD PRICE (b. 1723; d. 1791) was a dissenting clergyman whose approval of the French Revolution provoked a fiery retort from Burke; he is less known as a writer on morals and finance.

Other Groups of Scholars. Following DAVID HARTLEY (b. 1705; d. 1757) and ABRAHAM TUCKER (b. 1705; d. 1774) in adopting the theory of the association of ideas came JOSEPH PRIESTLEY (b. 1733; d. 1804), who, as a controversialist as well as a writer, was distanced by Bishop HORSLEY (b. 1733; d. 1806), the accomplished editor of Sir Isaac Newton's works. Priestley is best remembered as the "father of modern chemistry," the author of a "History of Electricity," and as the man who discovered oxygen, but by a blind attachment to theory failed to appreciate its significance, leaving that honour to Lavoisier. THOMAS PAINE (b. 1737; d. 1809) wrote an influential book on "The Rights of Man," in answer to Burke, and was himself very ably answered by GILBERT WAKEFIELD (b. 1756; d. 1801). The Greek scholarship of RICHARD PORSON (b. 1759; d. 1808); the translation of Demosthenes by Dr. THOMAS LELAND (b. 1722; d. 1785); the still unapproached translation of the Koran by GEORGE SALE (b. 1697 (?); d. 1736); the version of "Plutarch's Lives" by J. and W. LANGHORNE (b. 1735; d. 1779, and b. 1721; d. 1772); the standard translation of Josephus's "History of the Jews," by WILLIAM WHISTON (b. 1667; d. 1752); the still popular version of "Gil Blas" by TOBIAS SMOLLETT (b. 1721; d. 1771), whose "History of England" must also be noted; the translation of the "Satires of Horace" by the unhappy CHRISTOPHER SMART (b. 1722; d. 1770); the "Don Quixote" and the "Rabelais" of PETER ANTHONY MOTTEUX (b. 1660; d. 1718), who completed the work of Sir Thomas Urquhart, all testify to the learning and literary activity of the eighteenth century.

An Age of Scholarship. But this list, long as it is, and irrespective of the fact that we reserve fiction for separate consideration, is far from comprehensive. We have not yet mentioned the translations from the Sanskrit of Sir WILLIAM JONES (b. 1746; d. 1794), the scholarly discourses of Sir JOSHUA REYNOLDS (b. 1723; d. 1792), the valuable "Diversions of Purley" of JOHN HORNE TOOKE, the philologist (b. 1736; d. 1812); the histories and biographies of JOHN STRYPE (b. 1643; d. 1737), the educational manuals of ISAAC WATTS (b. 1674; d. 1748), the "History of England" and "History of the Puritans down to 1689" of DANIEL NEAL (b. 1678; d. 1743); the sprightly "Memoirs of the Reign of George II." of JOHN LORD HERVEY (b. 1696; d. 1743), the "Dialogues of the Dead" of the first BARON LYTTELTON (b. 1709; d. 1773), the colossal "Commentaries on the Laws of England" of Sir WILLIAM BLACKSTONE (b. 1723; d. 1780), the "Biblical Concordance" of ALEXANDER CRUDEN (b. 1701; d. 1770), the "Anecdotes" of JOSEPH SPENCE (b. 1699; d. 1768), the "Anecdotes of Samuel Johnson" by Mrs. THRALE (b. 1741; d. 1821), the essays of Mrs. CHAPONE (b. 1727; d. 1801), the "Travels"

of MUNGO PARK (b. 1771 ; d. 1806), or the admirable Shakespearian studies of RICHARD FARMER (b. 1735 ; d. 1797), GEORGE STEEVENS (b. 1736 ; d. 1800), ISAAC REED (b. 1742 ; d. 1807), EDMUND MALONE (b. 1741 ; d. 1812), and JOHN DENNIS (b. 1657 ; d. 1734).

Early Journalism. It is of interest to remember that "The Times," first started as "The Daily Universal Register" in 1785, came out with its present title on January 1st, 1788 ; that the "Gentleman's Magazine" dates from 1731 ; and that there was a "London Magazine" in 1732, a "Monthly Review" in 1749, a "Literary Magazine" and a "Critical Review" in 1756 ; while, in addition to other encyclopædias, the "Encyclopædia Britannica" appeared for the first time in 1771, in three volumes.

A Plea for General Knowledge. We have thus arrived at the end of the eighteenth century in our study of English prose, and have thought it well to maintain up to this point our historical treatment of the subject rather than to dwell at any length on the practical side of prose study or the examination of special branches of prose writing, though we have at least gleaned some useful knowledge by considering the different styles of the master-writers of the age. But presently we shall look more closely into the fabric of our English prose, now that we are coming into touch with the living and growing prose of our own time. This great distinction has to be noted between the eighteenth century and our own time : that the term "a man of letters" formerly stood — even into the middle of the Victorian Age—for one who had ranged at will in all those fields of study represented in our history of eighteenth century prose-writers : philosophy, travel, history, fiction, science, religion, etc. Unhappily, but perhaps inevitably, the nineteenth century saw a great change in the direction of "specialising," not only in the case of writers, but in that of readers. Authors now find it profitable to limit themselves to one branch of literature only ; readers, with far less reason on their side, are too prone to fall into the same habit. In the eighteenth century it was accounted no discredit to a writer that he expended his energies in many different fields of thought : that he wrote histories, biographies, poems, criticisms, philosophies, stories. In our day this would be to an author's disadvantage ; publishers would demand that he produce only the class of book which they could sell most rapidly. That is the author's excuse, and it is a valid one ; but the reader who confines himself to only one class of reading has no excuse. The man who to-day would be well read should go for example or precedent to the "men of letters" of the eighteenth century, who regarded the whole varied field of literature as their hunting ground, and were not content to linger unduly in one particular corner of it, but to range throughout its length and breadth.

Books to Study. "A History of Eighteenth Century Literature (1660-1780)," by Edmund Gosse (Macmillan. 7s. 6d.); "The Age of Pope," by John Dennis, and "The Age of Johnson," by Thomas Seccombe (Bell. 3s. 6d. each) ; "English Prose Selections," edited by Sir Henry Craik, with critical introductions by various writers (Macmillan. 5 vols. 7s. 6d. and 8s. 6d. each) ; "Eighteenth Century Vignettes," by Austin Dobson (Chatto & Windus. 4 vols. 6s. each) ; "Eighteenth Century Essays on Shakespeare," by D. Nichol Smith, M.A. (MacLehose. 7s. 6d.) ; "The Spectator," edited by G. A. Aitken (Routledge. 6 vols. 1s. each) ; Boswell's "Life of Johnson" (Froude. 5s.); the late Sir Leslie Stephen's "History of English Thought in the Eighteenth Century" (new edition, 1902) ; "The English Utilitarians," "Hours in a Library," and "Lives" of Johnson and Swift, in the "English Men of Letters" series. The more expensive works can usually be seen at the public libraries; where the student, having mastered the outline of the period, desires to read particular works, he should first of all secure lists of the cheap and excellent reprints now being published by so many leading firms. There is no better work of its kind than the "English Prose Selections," and Mr. Gosse's book is most helpful ; but Sir Leslie Stephen is the greatest authority on eighteenth century philosophy. The lighter side is safe in the hands of Mr. Austin Dobson.

Continued

THE SPINAL CORD & THE BRAIN

Shape and Functions of the Spinal Cord. Its Relation to the Nerves. The Size and the Weight of the Brain. Its Appearance

Continued from page 1944

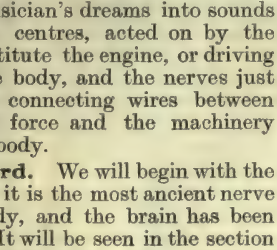
By Dr. A. T. SCHOFIELD

WE now approach the most difficult part of physiology—that borderland when it touches psychology, when body and soul, and matter and mind meet; for the central nervous system, composed of brain and spinal cord is the exquisite instrument that enables impulses of mind to be translated into movements of matter, just as a piano or organ materialises the musician's dreams into sounds of harmony. These centres, acted on by the mind and will, constitute the engine, or driving power, of the whole body, and the nerves just described are the connecting wires between those batteries of force and the machinery to be moved in the body.

The Spinal Cord. We will begin with the spinal cord, because it is the most ancient nerve structure in the body, and the brain has been developed from it. It will be seen in the section on Biology how far the spinal cord carries us back, whereas the brain proper is of much more recent origin. According to our custom so far, we begin with the structure, and then proceed to the functions of the nervous system.

The spinal cord is a flattened cylindrical band of soft material *eighteen inches long;* it is nearly one inch in diameter, and weighs about *an ounce.*

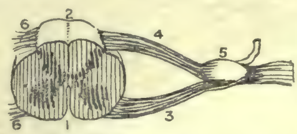
Its Shape. It is somewhat oval in shape, and one section is grey inside and white out. The cord, like the brain, is partly divided into right and left halves. All along it pairs of nerves are given off right and left, both in front and behind; and these pass out into the body between the vertebræ; while at the end the cord itself divides up into a bunch of white nerves called the *cauda equinæ*, because it is like a horse's tail.



110. SECTION OF SPINAL CORD IN THE CERVICAL REGION
a. Central tube *b.* Grey matter *c.* Posterior sensory nerves *d.* Anterior motor nerves *e.* White matter

Its Composition. The cord is really a tube, there being a small hole or foramen in the centre, running from end to end, lined with many ciliated epithelia. This tube is surrounded first by grey matter, then by white, and then by the membranes of the cord. These membranes are three in number, of the same name and similar in structure to those covering the brain; they will be fully described later on. The grey matter in the middle is somewhat in the shape of a butterfly with outstretched wings [110]. It is also like two large "commas" back to back, united by a band, in the centre of which the small tube runs. It consists of nerve cells and naked axis cylinders, and is rather pink, from the amount of blood which circulates in it, and is four times as great as in the white matter. This part of the cord consists of medullated nerves, blood-vessels, etc., all embedded in neuroglia, which is a close network of fibres. Grey matter contains four-fifths, and white matter three-fifths of water.

Its Work. The white matter gets less and less from above downwards, as the nerves composing it become fewer, while the grey matter suddenly enlarges at the spots where the nerves of the arms and legs are given off, there being here a great increase of nerve cells, owing to the great activity in the cord at these points. Only about half the spinal nerves that enter the cord pass into the brain, a large number terminating in the grey matter.



111. SECTION OF SPINAL CORD, SHOWING NERVES ON THE LEFT
1. Anterior cord 2. Posterior cord 3. Anterior motor nerves 4. Posterior sensory nerves 5. Ganglion on posterior nerve 6. Nerves on right

The spinal nerves come off in 36 pairs between the vertebræ, leaving the cord on each side by two roots, anterior and posterior. The anterior pass out in several bundles from the front of the grey matter of the cord, and are *efferent*, or *motor*, as is proved by the fact that all motion ceases in the part they supply when they are cut, while sensation persists. The posterior roots come off from the back of the grey matter in one large trunk, and shortly after they leave the cord, and before they join the anterior, they pass through a ganglion, or a swelling, composed of nerve cells on the trunk [111]. These are *afferent*, or *sensory* in character, as is proved by the part they supply losing all feeling when they are cut, while it still retains its powers of motion. The function of the ganglia has been explained in the section on Nerves to be that of nutrition.

Course of the Nerves. The course of the nerves in the cord is threefold:

The afferent, or sensory nerves, entering at the back, ascend to the brain along the posterior and lateral segments of the cord.

The efferent, or motor nerves, leaving at the front, descend from the brain along the anterior and lateral columns.

The third class, those terminating or originating

in the cord, constitute, as we have said, nearly half the entire mass.

One point should be noted, and that is that both motor and sensory fibres cross to the opposite sides—the motor fibres at the top, just before they enter the cord, and the sensory at the level with the cord, where they join after passing through the ganglia.

The centres of nutriment for the motor nerves are in the brain proper—any degeneration in them extends downwards; whereas, as we have seen, the nutritive centres for the sensory nerves are in the ganglia, or the posterior roots, and any degeneration in them extends upwards.

Four Functions of the Spinal Cord. The functions of the spinal cord are principally four in number—reflective, conductive, transferent, and trophic.

REFLEX ACTION consists in a response to a sensation, or it may be to an afferent impulse outside consciousness; it is fully described in that part of the course dealing with the brain.

CONDUCTION is the simple passing of nerve force through the cord to and from the brain.

TRANSFERENCE is the diffusion of nerve force to neighbouring nerves.

TROPHIC functions consist in the nutrition of nerves, and are well exhibited in the posterior ganglia of the spinal cord.

The Size and Weight of the Brain. We now turn to consider the brain, which forms in adults 1/40th part of the weight of the body (in horses 1/400; in elephants it is 1/500, and in whales 1/3000 part. The English brain averages 49 oz., the Scotch 50, and the Irish 47 oz. An idiot's brain may weigh as little as 16 oz., while a scientific man's (Cuvier's) may weigh 64 oz. Weight of brain does not, however, always mean great intellect, for a washerwoman's healthy brain has weighed as much. At three years old the brain is 9/10 of its full size; at twelve, 19/20; at fourteen it reaches it, though the development of functions may go on for long.

The Rhythmic Movement of the Brain. The first thing to be observed, if part of the skull-cap could be removed during life, is that the brain inside is continually moving. It throbs like a heart. If we put a finger on the membrane, or watch it and count the beats, we find they are just the same as the pulse. This movement of the whole brain is very remarkable. We do not feel it ourselves, unless it be very excessive, and then we say the brain throbs, or seems too large for the head. This throbbing is caused by the numerous blood-vessels that run everywhere in the soft, yielding cerebral substance; and as all these arteries beat with the heart, they move the whole brain up and down in regular rhythm.

[illegible] LEFT SECTION OF THE HEAD AND NECK

1. Cervical vertebrae
2. Dorsal vertebrae
3. Frontal lobes
4. Parietal lobes
5. Occipital lobes
6. Corpus callosum
7. Pons
8. Medulla
9. Arbor vitae in cerebellum
10. Cerebellum
11. Spinal cord
12. External openings of canals for spinal nerves
13. Nasal bone
14. Nostril
15. Hard palate
16. Soft palate
17. Inferior maxilla
18. Muscular substance of tongue
19. Hyoid bone
20. Tonsil
21. Pharynx
22. Epiglottis
23. Rima glottidis
24. Trachea
25. Thyroid body
26. Larynx
27. Oesophagus
28. Sternum
29. Bronchus
30. Branch of trachea

Turning from the brain to the inside of the skull-cap, we observe many channels and depressions grooved deeply in it, for the larger veins on the surface of the brain to run in. The brain itself cannot as yet be seen, as it has no less than three membranes, or coverings, over it, and the outer one is very thick and opaque. It is called the *Dura Mater*.

The Outside Covering. The Dura Mater (or Hard Mother) is so called because it is a tough, hard, and unyielding covering of the brain. Its outer surface is very rough, and adheres closely to the bones of the cranium, of which it forms the periosteum, while at the margin of the great hole for the spinal cord in the occipital bone it is continued downwards to form the outer covering of the cord, being, however, only loosely attached to the vertebrae. Its inner surface is smooth and glistening. It is made of a similar material to the white of the eye. It forms also the outer sheathing of the various nerves that pass out of the brain, and inside the skull its layers separate and form fibrous tubes, which are used as veins for the return of blood from the brain. The arteries that run on its surface are very numerous, and all help to supply the brain. The Dura Mater sends a strong arched division down like a

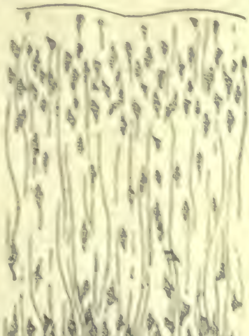
sickle, between the two halves of both the greater and lesser brains, stretching from before backwards; and also a horizontal layer between the lesser brain below and the greater brain above [118].

The Middle Covering. The Arachnoid (or Spider) membrane is so called from its delicate structure, resembling a spider's web. It is a closed and empty bag, consisting of two layers, and the brain is folded up in it. The outer layer rests against the dura mater, and the inner one against the third membrane of the brain. At the base of the brain a good deal of fluid often collects in the cavity, and thus forms part of the "water-bed," on which the brain rests. The main bulk of the fluid lies, however, *between the arachnoid and the innermost membrane*, in the space between the two. This fluid is watery, slightly saltish in taste, and is called cerebro-spinal fluid; it is very like lymph, and is the drainage of the brain.

113. POSTERIOR SURFACE OF MEDULLA
1. Anterior pyramid
2. Olivary body
3. Restiform body
4. Spinal cord

The Inside Covering. The Pia Mater (or Pious Mother), the innermost membrane of the brain, is so called because it takes such excellent care of the valuable organ—the brain—within it. It is a single layer of very fine membrane, holding together a perfect meshwork of blood-vessels that spread in all directions over the surface of the brain. It dips down between all the convolutions, and adheres closely to the brain substance beneath, though quite loosely to the Arachnoid above.

The Brain. When these three membranes are stripped off, the cerebrum, or brain, is seen beneath as a soft mass nearly 3 lb. in weight [117]. If we carefully take the brain out of its bony case, and examine it [112] minutely, we notice at once certain features. In the first place, there are two brains—the larger one, the cerebrum, in front and above; and the little one, the cerebellum, below and behind—the one as big as a melon, the other the size of a small orange. A girl's head with part of her hair done in a small knob behind very much resembles these two brains.

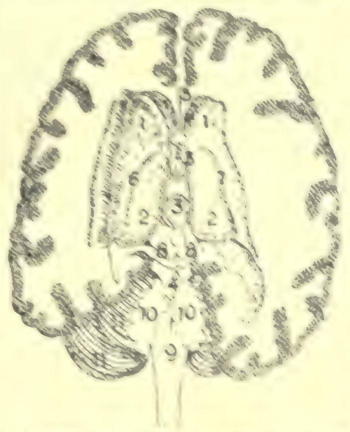


116.
LAYERS OF CORTICAL GREY MATTER OF CEREBRUM

115. ANTERIOR SURFACE OF MEDULLA
A. Pons B. Medulla

A Woman's Brain. Brains do not, as we have shown, all weigh alike. The average is about 45 oz., the extremes ranging between 1 lb. and 4 lb. In a child three years old the brain is only $\frac{1}{4}$ lb. lighter than a man's, and when it is twelve years old it is only $\frac{1}{8}$ lb.; and when fourteen, the brain has reached its full weight. After forty years of age the brain gets about an ounce lighter every ten years. The brains of women are about $\frac{1}{4}$ lb. less than those of men, not because they are lighter in proportion, but because the whole body is generally of a smaller size. The brain of the larger apes weighs under 1 lb.

Another feature is that both brains are divided by a cleft down the middle into two halves—right and left. The two halves appear exactly alike, and are joined together by a *broad band of white matter* about the centre of the cleft called the *Corpus Callosum*.



114. SECTION OF BRAIN FROM ABOVE
1. Corpus striatum 2. Optic thalamus 3. Third ventricle 4. Fourth ventricle 5. Fifth ventricle 6, 7. The two lateral ventricles 8. Corpora quadrigemina 9. Posterior surface of medulla oblongata 10. Section of cerebellum 11. Exterior of left hemisphere of cerebellum

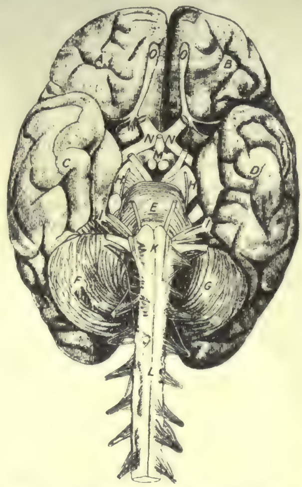
We next observe that the large brain may roughly be divided into *three regions, or parts*.

The upper part, which includes all the surface of the brain, or *cortex*, is a mass of convolutions, looking just like a number of snakes twisted together. Between the folds of these convolutions the *Pia Mater* dips down, carrying the blood-vessels. These folds are very intricate, and run in all directions. If the surface of the brain were flat, it would not be a quarter of the extent it is when folded up in convolution. The folds not only enormously increase the superficial area, but are connected closely with mind power, for the cleverer a man the deeper and more numerous they are. In a child they are

comparatively few and shallow, but rapidly increase with age and education.

The mid brain is quite different. It includes all the central part and under surface of the cerebrum, and consists of masses of nerve substance—two in front are called the *Corpora Striata*, and two behind the *Optic Thalami*.

The lower brain is called the *Medulla Oblongata* [**113**] (or oblong marrow), and connects the large brain with the smaller brain, or cerebellum, behind and the spinal cord below. It also is partly divided in two, and contains a long, hollow space (the fourth ventricle), and several small masses of nerve-matter the size of peas or beans.



119. THE BRAIN SEEN FROM BELOW

A. Right frontal lobe *B.* Left frontal lobe *C.* Right temporal lobe *D.* Left temporal lobe *E.* Pons Varolii *F* and *G.* Cerebellum *H.* Crus cerebri *I.* Crus cerebelli *K.* Medulla *L.* Spinal cord *N.* Optic nerves *O.* Olfactory nerves

There are also several other ventricles, or empty chambers, in the brain—one being as much as 4 in. long — with channels leading from one to another.

What the Brain Looks Like. If now, with a large, sharp knife, a horizontal slice is taken completely off the cortex, we get a very good view of the wavy external border of grey substance following the outlines of the convolutions, and looking just like the shaded margin that used to indicate the coast-line in all old-fashioned maps.

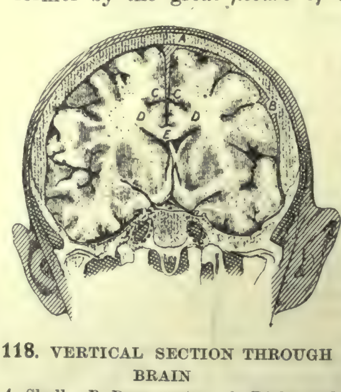
The Empty Spaces in the Brain. If a second horizontal slice be cut right down to the connecting band of white fibres, we get a still better view. The whole of the brain so far is *quite solid* and soft, like the curd of milk, white inside, and grey round the edges. The next slice will cut through the roofs of *two* of the five caverns, or *ventricles*, of the brain [**114**] which have long extremities like horns, and lie on each side of the connecting band and in the centre of each hemisphere. Their peculiar shape and the rounded masses rising inside them are very curious, and their use is not fully known. The other three ventricles are in the base of the brain and medulla, and are very small. Beneath the two lateral ventricles we reach the mid brain and the four large masses of nerve matter, two—the Corpora Striata—connected with motion, and two — the Optic Thalami—with sensation. Behind these, again, are four little bodies—the *corpora quadrigemina* —like four white peas, where the nerves of sight terminate, and where the power of sight really exists, for, if these are destroyed, the person is quite blind, though the eyes may be perfect.

117. THE BRAIN SEEN FROM ABOVE AFTER REMOVAL OF THE SKULL-CAP

A. and *B.* Left and right cerebral hemispheres *C.* Great longitudinal fissure **1.** Frontal lobe **2.** Parietal lobe **3.** Occipital lobe

The Lower Brain. Perhaps we may get a clearer grasp of the divisions of the brain if we follow them upwards from the spinal cord. When the cord reaches the brain it spreads out and flattens and divides from the back so as to be spread open like a split herring; this is the medulla, or lower brain, underneath [**115**]. Across its front is a broad band of fibres known as the *pons*, or bridge, which, passing upwards on each side, is connected with the little brain or cerebellum, which rests on the medulla above. Beyond this bridge of fibres the medulla divides into two great pillars—the *crura cerebri*—which pass up to the mid brain, each forming therein the two masses of grey, nervous matter we have seen—the Corpus Striatum in front, and the Optic Thalamus behind. From these masses two bands of fibres pass upwards and are folded backwards, right over the mid brain, forming eventually the two cerebral hemispheres and all the convolutions of the cortex in the upper brain.

The Five Lobes. There are five lobes in each half of the cortex—the *frontal* in front, the *parietal*, or middle lobe, separated from the former by the great *fissure of Rolando;* then the *temporal*, at the side, also separated from the first by the *fissure of Sylvius*. The *occipital* is behind, and is separated by the *parieto-occipital fissure*. In the centre is the fifth lobe, known as the *Island of Rheil*.



118. VERTICAL SECTION THROUGH BRAIN

A. Skull *B.* Dura mater *C.* Right and left hemispheres *D.* Parietal lobes *E.* Corpus callosum

About 2 in. down between the hemispheres, or slightly separating them, can be seen the broad white band of fibres that connects one side with the other

(*Corpus Callosum*). We will now look at these three divisions and the cerebellum a little more closely. If the convolutions of the cerebrum be examined in the upper brain, or cortex, they will be seen to have a grey appearance [116], and if cut, it will be seen that there are several very thin layers of grey and white matter alternately for about ½ in., and then the inside of the convolutions and the whole cerebrum are pure white. The depressions between the convolutions are about 1 in. in depth. Although the exact shape of the convolutions varies in each individual, just like the features in the face, yet there is always a general plan followed, so that the leading elevations and depressions have all received special names [118].

120. FOURTH VENTRICLE WITH LEFT CEREBELLUM (SECTION)
1. Fourth ventricle 2. Inferior crus 3. Superior crus of the cerebellum 4. Corpora quadrigemina 5. Left cerebellum (section)

Organs of Smell and Sight. At the base of the brain and in front we see embedded in the under side of the hemispheres of the cerebrum the two nerves of smell (olfactory bulbs) as they proceed forward to the nose [119]. They consist of two large masses of grey matter that receive the impression of odours, and two large white nerves that carry the sensation on to the brain. Further back you see two larger nerves crossing each other from right to left, and running backwards into the brain. These are the two optic nerves, or nerves of sight. The reason they cross, and thus mingle together, is in order that each eye may see alike.

The medulla is somewhat pyramidal in shape, and is about 1¼ in. long, 1 in. broad, and ¾ in. thick. The cerebellum that rests upon it is 4 in. by 2½ in. and 2 in. thick, and consists of a body and three pairs of bands, or cura, two upper ones connecting directly with the cerebrum, two forming the bridge, or *pons varolii*, and two connecting behind with the medulla direct [120]. The surface of the cerebellum is not in convolutions like the cerebrum, but is in fine vertical plates, all being grey outside and white within, the arrangement or section being in branches, like a tree.


121. BRAIN CELL
Isolated and highly magnified to show connections

The Nerves in the Brain. The nerves in the brain have been grouped generally into three great divisions.

1. Those that connect every part of the cortex of the hemisphere with the great ganglia of the mid brain (corpora striata, optic thalami, and the corpora quadrigemina), both motive and sensory.

2. Those that connect every part of these ganglia with the lower brain, or medulla, and the spinal cord, both motive and sensory.

3. The peripheral nerves that leave the spinal system and form the nerves proper.

The grey matter of the brain is composed of a basic substance — *neuroglia* — and closely-packed cells of every shape and size [121], with an interlacing network of naked axis cylinders.

The white substance is one mass of medullated nerves passing to and fro in all directions.

How Blood Feeds the Brain. The blood supply of the brain is of a special nature. The total amount passing through the brain is not very great, but five times as much circulates in the grey matter as in the white, the former being the true centre of metabolism in the nerve cells connected with the action of mind. There is probably a controlling centre in the brain for regulating its own blood supply. If this does not act well, any sudden change in the position of the head causes dizziness, or vertigo. The arteries leading to the brain are exceedingly tortuous, thus by mechanical means lessening the force of the heart's beats; and there is a circle of arteries at the base of the brain (the *circle of Willis*) to ensure a free supply to all parts. Large lymph spaces exist round the arteries, so that when these expand they do not press on the brain substance.

The large veins are not true veins, as they contain no muscle fibre, nor valves, but are open channels, called sinuses, formed by the bone and Dura Mater, and can neither be compressed nor distended.

Besides moving with the heart the brain rises and sinks a little with respiration.

NOTE. In the title to the illustration on page 1604 the words Tibia and Fibula should be transposed.

Continued

Group 21
MATHEMATICS
15
ALGEBRA
continued from page 1994

ALGEBRAIC MULTIPLICATION

Products of Compound and Simple Expressions, and Compound Expressions with each other. Homogeneous Expressions. Squares and Cubes

By HERBERT J. ALLPORT, M.A.

PRODUCT OF A COMPOUND AND A SIMPLE EXPRESSION

25. We must first prove that $(b+c)\times a = ba + ca$, whether a be a positive integer, or a fraction, or negative.

(i.) If a be a positive integer

Then, by definition,

$(b+c)\times a = (b+c) + (b+c) + (b+c) + \dots$ taken a times,
$= b + b + b + \dots$ taken a times,
$+ c + c + c + \dots$ taken a times,
$= ba + ca.$

(ii.) Since division is the inverse of multiplication, it follows from (i.) that to divide $(b+c)$, treated as a whole, by a positive integer, gives the same result as dividing b and c separately by that integer.

Therefore, if a is a positive fraction, equal, say, to $\frac{m}{n}$, we have

$(b+c)\times a = (b+c)\times\frac{m}{n},$

$= \frac{mb+mc}{n}$, from (i.),

$= \frac{mb}{n} + \frac{mc}{n}$, since the division of $(mb+mc)$ by n may be performed on mb and mc separately,

$= b\times\frac{m}{n} + c\times\frac{m}{n},$

$= ba + ca.$

(iii.) If a be negative, equal, say, to $-m$.

Then, by definition, to multiply $(b+c)$ by a we must do to $(b+c)$ what we do to 1 to obtain $-m$; *i.e.*, $(b+c)$ must be sub tracted m times. Thus,

$(b+c)\times a = -(b+c)-(b+c)-(b+c)-\dots$ m times,
$= -b-b-b-\dots$ m times,
$= -c-c-c-\dots$ m times,
$= -bm-cm,$
$= b\times(-m)+c\times(-m),$
$= ba+ca.$

These results are evidently independent of the values of b and c.

Hence, for *all values* of a, b, and c, we know that

$$(b+c)\,a = ba + ca.$$

26. Since the result is true for *all* values of a, b, c, it will be true when $b = p + q$.

Therefore,

$$(p+q+c)\,a = (p+q)\,a + ca,$$
$$= pa + qa + ca.$$

Proceeding in this way, we find that $(p+q+r+s+\dots)\,a = pa + qa + ra + sa + \dots$ is true, however many terms there may be in the expression $p+q+r+s+\dots$

But, it is clear that *any* compound expression can be written in the form $p+q+r+s+\dots$

For example, the expression

$$5x^3 - 3x^2 \div y + 6z$$

in which the *terms* are (i.) $5x^3$, (ii.) $-3x^2\div y$, and (iii.) $6z$, becomes $p+q+r$ if we write p for $5x^3$, q for $-3x^2\div y$, and r for $6z$.

Hence, *to obtain the product of a compound expression and a simple expression, we take the sum of the products formed by multiplying the separate terms of the compound expression by the simple expression.*

Example **1.** Multiply a^2-3a+2 by a^2.

We have

$$a^2\times a^2 = a^{2+2} = a^4$$
$$-3a\times a^2 = -3a^{1+2} = -3a^3$$
$$2\times a^2 = 2a^2,$$

remembering to apply the law of signs to each product.

The whole process is performed mentally, and all that need be written is

$$(a^2-3a+2)\,a^2 = a^4 - 3a^3 + 2a^2 \ \underline{Ans.}$$

Example **2.** Multiply $2x^2y + 7xy^3 - 3x^2y^2$ by $-3xyz$

$$(2x^2y + 7xy^3 - 3x^2y^2)\,(-3xyz)$$
$$= -6x^3y^2z - 21x^2y^4z + 9x^3y^3z \ \underline{Ans.}$$

Example **3.** Simplify

$$3a - 2\,[2b + 3\,(a-2b) - 2\,(b-a)]$$

The given expression

$$= 3a - 2\,[2b + 3a - 6b - 2b + 2a],$$
$$= 3a - 4b - 6a + 12b + 4b - 4a,$$
$$= -7a + 12b \ \underline{Ans.}$$

Here, a number outside a bracket means that, on removing the brackets, we must multiply every term between the brackets by that number. The rest of the process is the same as in Art. **20**.

PRODUCT OF TWO COMPOUND EXPRESSIONS

27. Suppose in Art. **26** that the value of a is $(x+y+z+\dots)$. We shall now be able to find the value of the product

$$(p+q+r+\dots)\times(x+y+z+\dots).$$

For, we have,

$(p+q+r+\dots)\times(x+y+z+\dots)$
$= (p+q+r+\dots)\,a,$
$= pa + qa + ra + \dots,$
$= p\,(x+y+z+\dots)$
$+ q\,(x+y+z+\dots)$
$+ r\,(x+y+z+\dots) + \dots,$
$= px + py + pz + \dots$
$+ qx + qy + qz + \dots$
$+ rx + ry + rz + \dots$
$+ \dots$

Hence, *to obtain the product of two compound expressions we take the sum of the products formed by multiplying every term of the one expression by every term of the other.*

Example **1**. Multiply $3x + 4y$ by $-x + 2y$.

The product

$= (3x + 4y) \times (-x + 2y)$,

or, as it is usually written [Art. **2**],

$$(3x + 4y)(-x + 2y)$$
$$= (3x)(-x) + (3x)(2y) + (4y)(-x) + (4y)(2y),$$
$$= -3x^2 + 6xy - 4xy + 8y^2,$$
$$= -3x^2 + 2xy + 8y^2 \text{ Ans.}$$

The work is generally arranged as follows,

$$\begin{array}{l} 3x + 4y \\ \underline{-\ x + 2y} \\ -3x^2 - 4xy \\ \underline{\quad\quad + 6xy + 8y^2} \\ -3x^2 + 2xy + 8y^2 \text{ Ans.} \end{array}$$

EXPLANATION. Write the multiplier under the multiplicand. Multiply every term of the multiplicand by the first term, $-x$, of the multiplier as in Ex. **1**. of Art. **26**. Next, multiply every term of the multiplicand by the second term, $+2y$, of the multiplier, writing "like" terms of the two products in the same columns. Finally, add the two lines, as in Ex. **1**. Art. **15**.

28. When the multiplier and the multiplicand consist of terms containing different powers of some common letter, it will be found convenient to arrange the terms in the following way:

In each expression put the term which contains the highest power of that letter first, the term which contains the next highest power next, and so on. This is called *arranging the expression according to descending powers of that letter*. The expression $3x^3 - 2 + 4x^2 - x + 5x^4$, when arranged according to descending powers of x, becomes $5x^4 + 3x^3 + 4x^2 - x - 2$. In a similar way we may arrange an expression according to *ascending* powers of some particular letter. For example, if we arrange $y^4 - x^3y + 2xy^3 - 5$ in ascending powers of y, we obtain $-5 - x^3y + 2xy^3 + y^4$.

It should be remembered, however, that this rearrangement of the terms, before beginning the multiplication, is not absolutely *necessary*. The reason for doing so is that it saves some trouble in getting the like terms of the product into the proper columns.

Example. Multiply $3x^3 - xy^2 + 2y^3 - 4x^2y$ by $y^2 + x^2 - 2xy$.

$$\begin{array}{lllll} 3x^3 - & 4x^2y - & xy^2 & + 2y^3 & \\ \underline{x^2 -} & \underline{2xy +} & \underline{y^2} & & \\ 3x^5 - & 4x^4y - & x^3y^2 & + 2x^2y^3 & \\ & - 6x^4y + & 8x^3y^2 + & 2x^2y^3 - 4xy^4 & \\ & & 3x^3y^2 - & 4x^2y^3 - xy^4 & + 2y^5 \\ \hline 3x^5 - & 10x^4y + & 10x^3y^2 & \quad - 5xy^4 & + 2y^5 \text{ Ans.} \end{array}$$

EXPLANATION. We have here arranged both expressions in descending powers of x. Note that by so doing we have also arranged them in ascending powers of y. We then work from left to right, multiplying first by x^2, then by $-2xy$, then by y^2, finally combining the like terms as in addition.

DIMENSIONS OF EXPRESSIONS

29. When a simple expression consists of the product of n letters, it is said to be *of n dimensions*, or, *of the nth degree. Numerical* factors do not affect the degree of an expression.

Thus, a^2, that is aa, is of two dimensions, or of the second degree. $5x^2yz$ is of the fourth degree, since it consists of the product of four letters, $xxyz$.

The degree of a compound expression is the degree of the term of highest dimensions contained in it. For example, $2a^3b - 4abc + c^2$ is of the fourth degree, since the term of highest dimensions, $2a^3b$, is of the fourth degree. But, in speaking of the degree of an expression, we sometimes only take one particular letter into account.

Thus, $2a^3b - 4abc + c^2$ is of the *third degree in* a. It is of the *first* degree in b, and the *second* degree in c.

An expression of the second degree is often called a *quadratic expression.*

HOMOGENEOUS EXPRESSIONS

30. *A homogeneous expression* is one in which all the terms are of the same dimensions.

$5x^7 - 3x^5yz + y^3z^4$ is a homogeneous expression of the seventh degree, since each term is of the seventh degree.

We have seen in Art. **27** that any term in the product of two multinomials is obtained by multiplying a term of the one multinomial by a term of the other. It is clear, then, that if each of the multinomials is homogeneous, their product will be homogeneous. For example, if every term of the multiplier is of the *second* degree, and every term of the multiplicand is of the *third* degree, then every term of the product will be of the *fifth* degree, since $2 + 3 = 5$. See the Example in Art. **28**. If every term in the product was not of the fifth degree, then we should know there was a mistake in our multiplication.

PRODUCTS BY INSPECTION

31. The student must learn to write down the product of two, or of three, such factors as $x + a$, $x + b$, $x + c$, without going through the process explained in Art. **27**.

If we do the actual multiplication we find that

$$(x + a)(x + b) = x^2 + ax + bx + ab,$$

which may be written

$$x^2 + (a + b)x + ab.$$

This result will be true whatever values a and b may have. A *general* result, such as the one just shown, is called a *formula*.

Let us now give special values to a and b. Suppose $a = 3$ and $b = -2$. Then we have

$$(x + 3)(x - 2) = x^2 + (3 - 2)x + 3(-2)$$
$$= x^2 + x - 6.$$

Or, if $a = -7$ and $b = 4$, we get

$$(x - 7)(x + 4) = x^2 + (-7 + 4)x + 4(-7)$$
$$= x^2 - 3x - 28.$$

We see, then, that the product of two such binomials as $x + 6$ and $x - 5$ consists of three terms, and that (i.) the first term is x^2; (ii.) the coefficient of x is the *sum*, taken with their

proper signs, of the second terms of the binomials; (iii.) the third term is the *product* of the same two terms.

In the same way, by actual multiplication, we find that the product of $x+a$, $x+b$, and $x+c$ is

$$x^3+(a+b+c)\,x^2+(bc+ca+ab)\,x+abc.$$

Hence we can at once write down the product of three such binomials as $x+2$, $x-1$, $x+4$.

Thus,

$$\begin{aligned}&(x+2)(x-1)(x+4)\\ &=x^3+(2-1+4)\,x^2\\ &\quad+\{2(-1)+4(-1)+2.4\}\,x+2.4.(-1)\\ &=x^3+5x^2+2x-8.\end{aligned}$$

After a little practice, the second line of work can be performed mentally, so that we have nothing to write down but the actual result.

SQUARE OF A MULTINOMIAL

32. We shall now show how the square of any multinomial can be written down by inspection.

In the formula

$$(x+a)(x+b)=x^2+(a+b)\,x+ab,$$

if we put $b=a$, we obtain

$$(x+a)^2=x^2+2ax+a^2.$$

That is, *the square of a binomial is equal to the square of the first term, plus the square of the second, plus twice the product of the two terms.*

Example **1.** Write down the square of $2a-3b$.

Here, we have

$$\begin{aligned}(2a)^2&=4a^2,\\ (-3b)^2&=+9b^2,\\ 2\,(2a)\,(-3b)&=-12ab.\end{aligned}$$

all of which can be done mentally, so that,

$$(2a-3b)^2=4a^2-12ab+9b^2\ \ \underline{Ans.}$$

In the formula $(x+a)^2=x^2+2ax+a^2$, suppose a is equal to $(y+z)$. Then we have

$$\begin{aligned}(x+y+z)^2&=x^2+2\,(y+z)\,x+(y+z)^2\\ &=x^2+2xy+2xz+y^2+z^2+2yz\\ &\text{or, rearranging the terms,}\\ &=x^2+y^2+z^2+2yz+2zx+2xy.\end{aligned}$$

Proceeding in the same way, we can obtain a formula for the square of the sum of *any* number of quantities. We may express the result in words, thus,

The square of any multinomial is equal to the sum of the squares of each term of the multinomial, together with twice the product of every pair of terms.

Example **2.** Square $a+2b-3c$.

$(a+2b-3c)^2=a^2+4b^2+9c^2-12bc-6ca+4ab$ $\underline{Ans.}$

Note that, whatever signs the terms of the given expression may have, the "square" terms of the result must, by the rule of signs, always be positive. We do not, therefore, have to trouble about the signs of the result until we come to the part which consists of "twice the product of every pair of terms."

After writing down the square of a multinomial, we must, if there are any like terms, collect them according to the ordinary rules.

Example **3.** Find the value of $(x^3-x^2+x-1)^2$.

The required value

$$\begin{aligned}&=x^6+x^4+x^2+1\\ &\quad-2x^5+2x^4-2x^3-2x^3+2x^2-2x\\ &=x^6-2x^5+3x^4-4x^3+3x^2-2x+1\ \ \underline{Ans.}\end{aligned}$$

NOTE. To make sure that we take *every* pair of terms, it is best to take "twice the product of every term into *every term which follows it.*"

CUBE OF A BINOMIAL

33. The student should also remember the *cube* of a binomial. We can obtain it from the formula

$(x+a)\ (x+b)\ (x+c)=x^3+(a+b+c)\ x^2+(bc+ca+ab)\ x+abc$ by putting b and c each equal to a. Thus,

$$\begin{aligned}(x+a)^3&=x^3+(a+a+a)\ x^2+(aa+aa+aa)\,x+aaa\\ &=x^3+3ax^2+3a^2x+a^3.\end{aligned}$$

Example. Write down the value of $(2b-1)^3$.

Here, the x of the formula becomes $2b$, and the a becomes -1. Therefore,

$$\begin{aligned}(2b-1)^3&=(2b)^3+3\ (-1)\ (2b)^2+3\ (-1)^2\ (2b)+(-1)^3\\ &=8b^3-12b^2+6b-1\ \ \underline{Ans.}\end{aligned}$$

The working should, of course, be performed mentally, nothing but the result being written down.

34. Before leaving multiplication, there is one other important result to be obtained from the formula

$$(x+a)\,(x+b)=x^2+(a+b)\,x+ab.$$

Suppose $b=-a$. Then we get

$$\begin{aligned}(x+a)\,(x-a)&=x^2+(a-a)\,x+a\,(-a)\\ &=x^2-a^2.\end{aligned}$$

Hence, *the product of the sum and difference of two quantities is the difference of their squares.*

EXAMPLES 5

Multiply

1. $x^2-xy+3y^2$ by $3x^2y$.
2. x^3-y^3+1 by $-4xy$.
3. $a^2y^2-abx^2+acz^2-2bcyz+2c^2xy$ by $-5abcxyz$.
4. x^2-xy+y^2 by $x+y$.
5. x^2+xy+y^2 by $x-y$.
6. x^2+ax-a^2 by x^2-ax+a^2.
7. x^3-2x+3 by $x-1$.
8. x^3+ax^2-bx-c by x^2-ax+b.
9. $3x^2y^2-x^4+2y^4$ by y^2-x^2+xy.
10. $a^2-ab-ac+b^2-bc+c^2$ by $a+b+c$.

Using the result of Art. **34** find the continued product of

11. $1-x$, $1+x$, $1+x^2$.
12. x^2+xy+y^2, x^2-xy+y^2, $x^4-x^2y^2+y^4$.

Simplify

13. $(a+b+c)\,(b+c-a)\,(c+a-b)\,(a+b-c)$.
14. $(x-y)^2+(y-z)^2+(z-x)^2$.
15. $(x+2)\,(x+3)\,(x+4)\,(x+5)$.
16. $x^2y^2\,(p^2-q^2)+p^2q^2\,(x^2-y^2)+p^2y^2\,(q^2-x^2)+q^2x^2\,(y^2-p^2)$.
17. $9\,(x-3)\,(x+3)+2\,[(x-2)^2-\{2\,(x-4)\,(x+5)+3\,(x-1)^2\}]$.

Find the following squares

18. $(x-3y+4z)^2$.	**20.** $(a+b-c-d)^2$.
19. $(3a^2-2a+5)^2$.	**21.** $(a+b)^2(a-b)^2$.

Find the cube of

22. $3x-y$.	**24.** $x+y+z$.
23. $1-4a$.	**25.** $x-y-z$.

DIVISION

35. Division is the inverse of multiplication. When we divide 6 by 2, we find the quantity by which 2 must be multiplied in order to produce 6. Similarly, when we divide a by b, we find the quantity by which b must be multiplied to produce a.

Now, in Art. **22**, we saw that successive multiplications can be done in any order. Therefore, successive divisions can be done in any order. Hence, a succession of multiplications and divisions can be done in any order. For example, if we multiply a by b, and divide the product by c, we obtain the same result as if we divide a by c and multiply the quotient by b.

36. In Art. **21** we saw that

(i.) $(+a)\times(+b)=+ab$.

Therefore

$$(+ab)\div(+a)=+b.$$

(ii.) $(+a)\times(-b)=-ab$.

Therefore

$$(-ab)\div(+a)=-b,$$

and

$$(-ab)\div(-b)=+a.$$

(iii.) $(-a)\times(-b)=+ab$.

Therefore

$$(+ab)\div(-a)=-b.$$

On examining these results we see that, just as in the case of multiplication, "like signs give +, unlike signs give −." Thus, *the Law of Signs is the same for division as for multiplication*

37. In Art. **23** we showed that $a^3\times a^4=a^7$. If, then, we divide a^7 by a^3, we obtain a^4 for quotient.

That is,

$$a^7\div a^3=a^4=a^{7-3}.$$

Therefore, *when one power of a letter is divided by another power of the same letter, the index of the quotient is found by subtracting the index of the divisor from the index of the dividend.*

38. We are now able, by using these results, to divide one simple expression by another.

Example 1. Divide $14x^3y^4$ by $7xy^2$.

$$14x^3y^4\div 7xy^2=(14\div 7)\times(x^3\div x)\times(y^4\div y^2)$$ by Art. **35**.

$$=2\times x^{3-1}\times y^{4-2},$$ by Art. **37**.

$$=\underline{2x^2y^2\ \textit{Ans.}}$$

As in multiplication, it is clear that we can write down the result at once, the steps shown above being done mentally. We (i.) write down the sign of the quotient, (ii.) divide the numerical coefficient of the dividend by that of the divisor, (iii.) write down each letter that occurs; the index of its power being found by subtracting the index of that letter in the divisor from the index of the same letter in the dividend.

Example 2. Divide $-15a^7b^4c^3$ by $3a^4b^2c^2$.

$$-15a^7b^4c^3\div 3a^4b^2c^2=\underline{-5a^3b^2c\ \textit{Ans.}}$$

Here we have "unlike signs give −." Then $15\div 3=5$. Next, $a^7\div a^4=a^3$, and so on.

39. It should be noticed that when a power of a letter is divided by the *same* power of that letter, our rule gives us 0 for the index of the quotient.

Thus,

$$x^4\div x^4=x^{4-4}=x^0.$$

But it is evident that $x^4\div x^4$ is 1. Hence, a quantity whose index is zero is equal to 1.

Answers to Algebra

EXAMPLES 3

1. $2a-[b-\{a-2b-a\}]=2a-[b+2b]=2a-3b$ *Ans.*

2. $3x-[1-\{3x+1-3x+1\}]=3x-[1-2]=3x+1$ *Ans.*

3. $a+b-[-c+a+2b-a-c]=a+b+2c-2b=a-b+2c$ *Ans.*

4. $-\{-1+1+2\}-[2+1-2-3]=-2+2=0$ *Ans.*

5. $x^4-x+3x^3+x^2+x-1-[-3+x^4+3x^3+x^2+1]=x^4+3x^3+x^2-1+3-x^4-3x^3-x^2-1=1$ *Ans.*

6. $\frac{1}{2}x-\frac{3}{2}y-\frac{1}{4}z-\frac{1}{2}x-\frac{1}{2}y+\frac{1}{4}z+x=x-2y$ *Ans.*

EXAMPLES 4

1. $28a^7$.	**7.** ab^2cxy.
2. $12x^4$.	**8.** $-20cx$.
3. $-2x^2y^2$.	**9.** $-60a^2b^2c^2$.
4. $-6a^5bc^4$.	**10.** $-6a^4b^3c^2x^3$.
5. $44a^2bc$.	**11.** $-x^3y^4z^3$.
6. $-2a^5b^7c^4$.	**12.** $-48ab^2c^2x^3y^2z^3$.

13. $2ax^2y=2\,.\,(-1)\,.\,4\,.\,3\,.=-24$ *Ans.*

14. $5a^2y^3=5\,.\,1\,.\,27=135$ *Ans.*

15. $3xy+4y^2z-5a^3=-18+0+5=-13$ *Ans.*

16. $(2x+3y)^2-3(a^2+z^2)=(-4+9)^2-3(1+0)=25-3=22$ *Ans.*

17. $2ax-\{3x^2y-\overline{4xyz-a^3}\}=4-\{36-0-1\}=-31$ *Ans.*

18 $\sqrt[3]{6ax^5y^2}=\sqrt[3]{6\,.\,(-1)\,.\,(-32)\,.\,9}=\sqrt[3]{2^6.\,3^3}=2^2.\,3=12$ *Ans.*

19. $\sqrt[3]{\dfrac{a^2+xy}{5x^3}}=\sqrt[3]{\dfrac{1-6}{-40}}=\sqrt[3]{\dfrac{-5}{-40}}=\sqrt[3]{\dfrac{1}{8}}=\dfrac{1}{2}$ *Ans.*

20. $\sqrt{6ax^3y}\div\sqrt[4]{12a^2x^2y^3}=\sqrt{144}\div\sqrt[4]{2^4.\,3^4}=12\div 6=2$ *Ans.*

Continued

Group 28
TRANSIT
1

VARIOUS METHODS OF TRANSIT

Natural and Vehicular Transport. The Bicycle and the Automobile. Relative Speed and Cost of Various Methods of Transit

By F. L. RAWSON

As an ambulatory biped, man from the remotest ages has possessed the power of moving from place to place. In the beginning he relied solely upon the means with which Nature had provided him, and for all ordinary purposes he needed no other. The average man can maintain on foot a speed of four miles an hour for several hours, and can traverse more than 30 miles in a day's march of 10 hours without undue effort. For short distances a walking pace of over nine miles an hour can be attained under racing conditions, and over eight miles has been covered within one hour. On forced march, with the usual impedimenta, British soldiers have traversed a distance of 43 miles in 32 hours.

When running, a man can cover 11½ miles in the hour on a racing track, but the effort is severe; in semi-civilised countries, however, the natives possess remarkable powers of running for prolonged periods. For example, the native letter-carriers of India are accustomed to maintain a steady trot for many hours, without apparent effort, over rough country, in a way that would be a physical impossibility to a European under similar conditions.

Animal Service in Transit. In civilised countries the roads are kept in good order, and progress on foot is therefore easy and comparatively speedy; but in unsettled countries, where roads are poor or absent, walking is a poor and inefficient means of transit, and in any case the transport of goods on foot is an arduous process. Hence it came about that at a very early stage of human civilisation the assistance of animals was invoked. Whether camels, oxen, or horses were the first to become the servants of man need not concern us. While even to this day the camel is the only animal capable of crossing long stretches of desert land without ample supplies of food and water, the horse is by far the most generally serviceable beast of burden.

The Horse. A horse walks at about four miles an hour and trots about 10 miles an hour; it can traverse 60 miles in a day without injury. This gives the rider a range twice as great as that of a pedestrian. Moreover, while the horse cannot travel fast over rough and stony ground, it is far less dependent than man upon good roads, and, indeed, is most at home upon rolling grassland. Riding is practically as safe as walking, and twice or thrice as speedy. The first cost of a good riding horse of course varies with local circumstances, but may be put in this country at about £50, while its useful life is at least 12 years. Allowing for interest at 5 per cent., and taking account of the life of the animal, the annual charges on capital account amount to £7 per annum. The keep of a horse costs, in England, about 15s. a week, or, inclusive of shoeing, stabling, and attendance, about £1 per week. Thus, it costs at least £59 a year to keep a horse for riding, without reckoning contingencies.

The daily cost is much the same whether the horse is used every day or not; but allowing a distance of 120 to 150 miles as a fair week's work, the cost per mile amounts to from 1·8d. to 2·3d. at least.

Vehicular Transport. A man who undertakes a long journey, for example, in a new or undeveloped country, such as Australia or Rhodesia, must provide himself with means of transporting his household and other goods, and this cannot be conveniently accomplished, except under special circumstances, without the aid of vehicles. Even in civilised countries railways cannot penetrate everywhere, and transport over the common roads must be carried on as economically as possible. Taking the latter case first, the subject naturally falls under two heads: the transport of men at a comparatively rapid pace, and that of goods at a low speed. Two classes of vehicles are therefore necessary, and two kinds of draught animals.

Light Vehicles. A light vehicle, such as a dogcart, drawn by one horse, proceeds at the average rate of 10 to 12 miles an hour, and has a range of 30 or 40 miles a day—much more, if relays of horses are employed. Estimating the cost of the vehicle and harness at £50, and allowing 5 per cent. for interest, 10 per cent. for depreciation, including repairs, the annual expenditure entailed by the possession of a dogcart is £7 10s., and with that of a suitable horse, as before, amounts to a total of £66 10s. If the vehicle were driven for 30 miles daily, the cost of repairs would be greater, but this is not the average condition. Assuming, therefore, that the charges are as stated, the cost per mile of vehicular transit by this means, on the basis of 120 to 150 miles per week, may be estimated at about 2·3d. per mile, and if an attendant is employed this will be at least doubled.

Turning to the transport of goods, this is most economically effected in large waggons, drawn by two or more horses, at a speed of 2½ to 3 miles per hour. The burden constituting a load depends upon the nature of the goods carried, but the weight that can be hauled on ordinary roads under the conditions named is about 2 tons per two-horsed waggon. The cost of such a waggon is £40. Allowing

5 per cent. for interest, and estimating the life of the waggon at, say, 15 years, the annual charges amount to £5. Labour will cost, roughly, £65 per annum. The first cost of the draught horses, which are heavy animals, and require more food than carriage horses, will amount to £100, and their keep, stabling, etc., to £110. The total annual cost of the two-horsed waggon is therefore £194, and, allowing for a total journey of 20 miles a day, six days a week, the cost per ton-mile is $3\frac{3}{4}$d. If either the load or the distance be less, the cost will be proportionately increased.

Ox Transit. In countries such as the Transvaal, while riding and driving in light carts are the customary means of travelling in person, goods are conveyed in waggons hauled by oxen at a very slow pace, not more than $1\frac{1}{2}$ miles an hour; the roads are very primitive, and often as many as 20 oxen are harnessed to a single waggon. Bullock carts are also largely used in India and other Eastern countries, and in the latter personal transit is more commonly effected with light hand-carriages, called jinrikshas, or "rickshaws," hauled by native runners, than on horseback.

Town Transit. The means of transit available in towns, especially large ones, with dense populations and often narrow streets, stand in a category of their own. The subject is one of immense importance, and, in such a city as London, is of vital interest to all classes. Naturally the horse has hitherto occupied a prominent position in this connection, and, apart from railways, has remained until recent years practically the only available agency for carrying on the transport of passengers and goods. In addition to innumerable private carts, waggons, carriages, etc., there are in London about 11,500 cabs for hire, and 3,600 omnibuses, besides about 2,000 tramcars. All these ply upon the common roads, and the congestion of traffic is such that, according to the Report of the Royal Commission on London Traffic, the loss of time due to this cause alone amounts to 30 or 40 per cent.

Omnibuses. Omnibuses are public conveyances usually carrying passengers on the roof as well as inside, to the number of about 26, and are hauled by two horses at the rate of six to eight miles an hour on the average. The fares are in the neighbourhood of 1d. per mile. Such vehicles form a most valuable means of transit, though the pace is slow, and in many parts of London they are the only means. They have been accused of being to a great extent the cause of the congestion of the London streets, but this contention is easily refuted. The most fruitful sources of delay are the slow-moving carts and waggons with which the narrow streets are encumbered, and especially the vehicles which are kept standing at the roadside whilst loading or unloading, thus reducing the available width of the roadway often to the extent of 25 or 30 per cent. If the main streets could be rid of these, and reserved solely for the quick-moving traffic, the congestion would be very greatly lessened. In towns which are more fortunate than London in the possession of wide streets, omnibuses have been largely superseded by tramcars, to which we shall refer later.

The Bicycle. Not everyone can afford to keep a horse, and, therefore, the evolution of a cheap and reliable bicycle from the old boneshaker during the last twenty years has resulted in the manufacture and sale of an enormous number of these machines. The invention of the pneumatic tyre was of supreme importance, rendering the motion smooth and agreeable, and greatly increasing the average speed attainable. A well-made and durable machine can now be obtained for £6 or £8, and will last for several years, if kept in good order and repair. The maximum distance traversed in an hour on a racing track is 54 miles 750 yards, and on ordinary roads over 226 miles have been covered in 12 hours, thus leaving horses and men on foot far in the rear. Without forcing the pace, it is easy to maintain a speed of 15 miles an hour, and to cover 100 miles in a day. Bicycles, however, are ill-adapted for carrying weight other than that of the rider. Allowing for a total outlay of £4 per annum, the cost per mile (150 miles a week) is $\frac{1}{8}$d., so that the bicycle is one of the cheapest means of transit.

The Motor Bicycle. The introduction of the small, high-speed, internal combustion engine for the propulsion of road vehicles was soon followed by its application to the bicycle, and led to the development of very high speeds on the racing track (one kilometre in $26\frac{2}{5}$ seconds, equalling a speed of 84·68 miles an hour, having been reached), but not to any great extent on ordinary roads, owing to the legal restrictions and the necessity of exercising caution in the presence of other users of the highway. Except for individual use, the bicycle obviously cannot form an important factor in locomotion.

The Automobile. The modern automobile, on the other hand, is destined to exercise immense influence on the transit problem, and its meteoric development during the last ten years has resulted in the evolution of various types of automobile cars adapted to every modern requirement. The speeds attainable are equal to, or even greater than, that of the fastest express train (a kilometre having been covered in $21\frac{2}{5}$ seconds, or at the rate of 104·52 miles an hour), while the car remains under the most perfect control, as regards both the steering and the ability to stop in a very short space. The high speed is due to the great advances made in recent years in the design and construction of small engines.

Thanks to the accuracy of modern manufacturing methods, it has become possible to run these at very high rotative speeds, thereby enabling them to develop large powers with small weight. The use of volatile liquids, such as petroleum spirit (petrol), alcohol, etc., exploded in the cylinders of these engines in the form of vapour mixed with air, and thus dispensing with the complications due to the use of steam, has made them capable of running

continuously without attention, a condition essential to success in the case of a car running at considerable speed on the common roads. It is true that some types of automobiles are driven by steam, but this agent is now little used except for heavy goods waggons. Improvements in automobile propulsion may be expected in the application of steam or gas turbines and the use of paraffin instead of petrol as a fuel. Paraffin or petroleum costs only half as much as petrol, and the only obstacle to its use is the difficulty of carburetting properly.

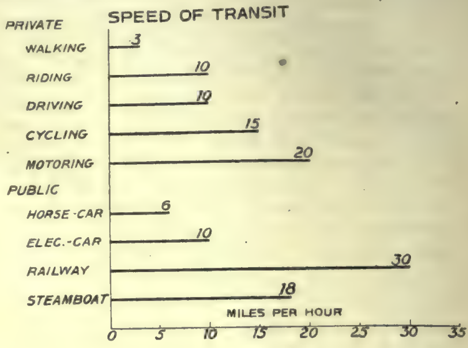
Cost of Automobiles. Although great reductions in the cost of automobiles have taken place during the last few years, they are still very expensive machines, both in first cost and in upkeep. The latter is largely due to the indiarubber tyres, which are indispensable adjuncts to comfort in travelling, but are, unfortunately, subject to very rapid wear. A set of tyres for a motor-car costs from £20 to £60, and lasts for not more than 4,000 to 5,000 miles, so that, for tyres alone, the cost per car-mile amounts to 2d., or, say, per passenger per mile, ½d. Allowing for interest and depreciation on the cost of the car, stabling and attendance, and the cost of petrol, the total cost per passenger per mile may be estimated at 2½d. for a four-seated car, assuming that all four seats are occupied, and that the average distance covered is 150 miles a week.

For the transport of goods the heavy motor waggon has already amply proved its worth, and has quickly come into general use. Such waggons are built to carry from three to six tons, at speeds from 2½ to 5 miles per hour; the driving motors are usually actuated by steam, at very high pressure (220 lb. per square inch), and are rated at from 25 to 45 indicated horse-power. These waggons are not provided with rubber tyres, but with broad and heavy wooden wheels, shod with steel tyres. The cost of transport carried on by their means is about 3½d. per ton-mile. Faster and lighter vans are made for delivering parcels, and motor-vans driven by petrol engines have been adopted by the British Post Office for carrying the mails in and between certain towns.

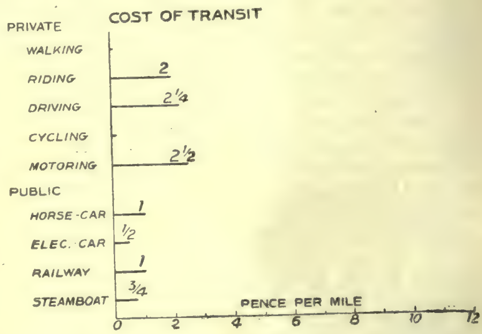
Comparison of Methods of Transit. It may be opportune at this point to summarise the data given in the foregoing and subsequent sections, and this is most conveniently done by means of diagrams. We must here point out the enormous importance of the element of time in comparing rival systems of transit. Time, says the proverb, is money, and certainly to the busy man it has a very real value. Considerations of space compel us to confine ourselves to a single example, and for this purpose we shall take the case of a man whose time is valued at half-a-crown an hour, or ½d. per minute. Our readers can readily work out for themselves any other case in which they may be more directly interested.

These diagrams are very instructive. It will be seen that the time allowance puts an entirely different complexion on the matter. The fastest mode of transit at once becomes the cheapest, and if an express train be used, the railway is by far the cheapest, for then the cost per mile will come down to but little over 1·5d. Walking would at first sight seem the most economical means of transit, costing nothing but shoe-leather; yet it proves to be the most expensive.

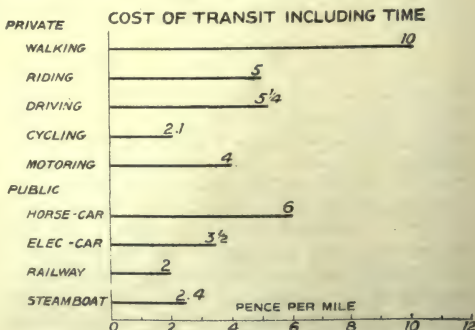
The first diagram gives the relative speeds attainable under practical commercial conditions for personal transit, with which we are mainly concerned:



We take next the actual outlay entailed by various means of transit, without allowing for the cost of time expended:



Lastly, let us see the effect of taking time into consideration, on the aforesaid basis:



The diagrams must be regarded not as absolutely exact under all circumstances, but as only approximately true.

Continued

WEAPONS & COLOURS OF MAMMALS

Development of Brains. Horns and Antlers. Skin, Fur, and Scales as Armour. Various uses of Colours. Other Ornamentation

By Professor J. R. AINSWORTH DAVIS

THE backboned animals which first dominated the land were amphibians, now represented by newts, salamanders, frogs and toads. Later these were supplanted by a branch of their own stock—*i.e.*, reptiles—which adapted themselves to all sorts of conditions, and presented a great variety of groups, most of which are now entirely extinct. The members of this class in their turn yielded to mammals and birds, both of which are improvements upon the remote reptilian ancestors from which they have undoubtedly sprung.

The Blood of Reptiles. The success of both birds and mammals in the struggle for existence is primarily due to the fact that their circulatory and breathing organs have become extremely efficient. The latter purify the blood very thoroughly, and in the former there is no mixing of pure and impure blood, as in amphibians and reptiles, which are both greatly handicapped by the circumstance. They have, in fact, only partly succeeded in adapting the fish circulation they have inherited to the conditions which obtain on land. The advantage which birds and mammals have gained in the directions indicated means increased energy, enabling them to cope advantageously with competing lower types.

Mammals, again, have become specially fitted in several ways for both offensive and defensive warfare. All but the spiny ant-eater and duck-billed platypus—now on the way to extinction—have abandoned the primitive device of egg-laying, their young being born "alive." Parental care after birth gives the young animals a good start, and the milk diet provided for them obviates many difficulties as to feeding. Even the primitive mammals just mentioned show great solicitude in the care of their young, and possess milk glands.

The Value of Brains. An even more important advantage gained by mammals in the course of evolution has been the development of a relatively large brain, which is correlated with marked intelligence, a leading factor in the struggle for existence, and a concrete illustration of the principle that "the race is not always to the swift, nor the battle to the strong." Man himself is, of course, the most remarkable example of this, while, on the other hand, there are certain extinct groups of mammals which have become extinct because their brains did not develop to a sufficient extent, and which have perished so to speak from sheer stupidity.

Preservation of the Weaker Orders. Coming now to special methods of defence among mammals, we find that among the weaker orders, such as the GNAWERS (*Rodentia*), great fecundity largely compensates for disabilities in other directions, and prevents many species from becoming extinct. The rabbit has become proverbial in this respect. Many, too, of the ill-defended forms have adopted modes of life which have reduced the pressure of competition. Some of them have taken to burrowing, others have become aquatic, still others are arboreal, and bats have developed organs of flight.

260. BULL'S HEAD

Many mammals are in the possession of more or less efficient weapons, which stand their owners in good stead in the event of attack. Some of these, such as the sharp teeth and claws of the cat-like types, are primarily offensive in character, but serve equally well for the other purpose. And in vegetarian forms we find a great variety of weapons which are primarily of use in what may be termed active defence. A good instance is afforded by the formidable tusks of the elephant and wild boar.

Horns. Actively defensive weapons are also the horns and antlers of many species, of which a great variety are to be found among the HOOFED MAMMALS. One type is that possessed by the Indian buffalo, the American bison, oxen [260], sheep, goats, and antelopes. There are here two bony outgrowths from the top of the skull, covered by horny sheaths of varying shape, the sharp points of which are well calculated to meet attacks. Those of the sable antelope of Africa, for example, sometimes enable their possessors to transfix an aggressive lion. In antelopes these weapons are nearly always limited to the males.

Antlers Indicate Age. The antlers of deer [261], also possessed by the male only, as a general rule are of very different character, being bony outgrowths from the skull, which are shed annually, and in many cases become more complex each year, this serving as an indication of age. Until their full size is attained they are covered with soft, hairy skin, the "velvet," after which a projecting ridge, the "burr," grows out at the base of the antler, and stops the circulation of the blood in the skin-layer, so that it dies and peels away, and the antler itself, being deprived of its nourishment, becomes dead bone, to be cast off later. Being insensitive, it makes a particularly serviceable weapon. Antlers, however, are not merely used in active defence, but also in the annual fights which take place between the polygamous males for the possession and holding of establishments.

The Unicorn. The curious epidermal horn or horns of a rhinoceros are formidable weapons of quite a different kind, which, like the paired horns of oxen, etc., are not periodically shed and renewed. The emblematic "unicorn" was probably founded upon imperfect knowledge of the Indian rhinoceros by someone possessed of a lively imagination. In one of the dolphin-like cetacea living in Arctic seas, the narwhal (*Monodon*), a long ivory spear marked with a spiral groove projects from the snout of the male, and was at one time considered to be a "horn." In reality, it is a much elongated incisor tooth, comparable to the tusk of an elephant; sometimes a pair are present.

Reid

261. RED DEER

Armour. Mammals often possess structures which, being used in passive defence, may be grouped under the heading of "armour." The skin may be very tough and thick, as in the elephant and rhinoceros, or the fur may be so dense as to be a protection. The excessive development of hair on the head and neck of a lion very possibly serves to guard the throat during fights with other individuals of the same species.

Spines. In several orders a number of hairs are transformed into spines, which help to ward off attacks. Examples are afforded by the spiny ant-eater (*Echidna*) of Australia, the hedgehog (*Erniaceus*) [231, page 1490], and the porcupine (*Hystrix*) [262]. Almost everyone living in the country has probably observed the way in which this *chevaux-de-frise* is displayed to the best advantage by an alarmed hedgehog, when it rolls itself into a ball, and remains motionless until the danger is past. A powerful layer of muscle in the skin renders this possible.

Among mammals poor in teeth (*Edentata*) we find both scale and plate armour. The former is affected by the pangolins of Africa and Asia, in which the body is defended by horny, overlapping scales. In the armadillos of South America, there are bony plates in the skin [263] which serve a similar purpose. Some of these creatures are able to roll up like hedgehogs. Other special methods of defence are included under the next heading, and we may here note the great powers of speed possessed by many hoofed mammals, their gregarious habits, and their powerful hoofs, all contributing to foil or repel attacks. Some of them set sentinels while the herd grazes, to give notice of approaching danger. The power of ruminating, or "chewing the cud," which some of them have acquired, has already been mentioned as a protective habit.

The Colours of Mammals. As reference will from time to time be made to animal colouration in connection with various groups, it may be well to give a general classification of colours and markings, to be illustrated for the present by reference to mammals only:

1. Protective Colouration. (*a*) General; (*b*) special. 2. Aggressive Colouration. (*a*) General; (*b*) special. 3. Warning Colouration and Mimicry. 4. Courtship Colouration. 5. Signalling Colouration. 6. Recognition Colours and Markings.

Protective colouration is of such a nature that it renders its owner inconspicuous, and therefore more difficult for foes to discover. When it is "general," the result is a harmonising with surroundings of which the animal so protected appears to form a part. This is why the upper side of the body is so often darker than the under, a sort of "reversed shading," which takes away from the appearance of solidity.

Summer and Winter Dresses of Animals. No better example could be taken than that of the wild rabbit. In countries where there is a marked difference of temperature between summer and winter, some mammals change the colour of their fur. The variable hare, for instance, which ranges east from Ireland and Scotland to Japan, has a dark summer and a white winter coat, the difference being most clearly marked in the northern part of its area of distribution.

Protective colouration is "special" when it brings about a resemblance to some particular inanimate object. A squatting hare, for example, looks very much like a clod of earth. It is said that the two-toed sloth of South America presents a striking resemblance to a lichen-covered bough, brought about by its dull, rough hair, on which a small green alga grows; and in one species there is an oval brown patch between the shoulders, which suggests the broken-off end of the sham bough.

Ermine a Winter Dress. Aggressive colouration is of much the same character as the preceding, but its purpose is different, for it enables flesh-eating forms to escape the observation of their prey. The tawny hide of the lion, and the spotted coat of the leopard are cases in point, and so is the white fur of the Polar bear. There may also be, as before, summer and winter coats of different colour. Our native stoat (*Putorius erminea*), for instance, has a reddish-brown back in summer, while in winter—in north Scotland—it turns white, except that the tip of the tail remains black. This winter dress is the source of the valuable fur called " ermine."

Warning colouration is of such a kind as to make its possessor very conspicuous, and may be taken as an advertisement of unpleasant properties, which only a particularly hungry enemy would care to face. The common badger (*Meles taxus*) belongs to an evil-smelling group, and here the upper side of the body is light-coloured, contrary to the general rule. The American skunk (*Mephitis suffocans*) possesses glands from which it can squirt out an irritating fluid of indescribable odour, and this property is advertised by a white back and a large bushy white tail, which serves as a " danger flag."

The term mimicry is applied to cases where a " mimic," devoid of unpleasant characters, closely resembles a " model " which is defended by warning colouration. Plenty of instances are to be found among insects, as we shall later on have occasion to see.

Moustaches and Courtship. Courtship colouration applies to cases where one sex, usually the male, possesses gay adornments, supposed to facilitate love affairs. We see this in some male baboons, which are decorated

Medlana

263. ARMADILLO

with vivid red or blue, both fore and aft. It is not improbable that the moustaches and beards of men were evolved for similar reasons, and they are said still to retain their original use to some extent. Some male monkeys possess a similar adornment.

Signalling colouration is exemplified by some of the gregarious mammals, and serve to announce the approach of danger. The white tail of the wild rabbit, so conspicuous when it runs, probably has this use. It may also be noted here

262. PORCUPINE *Medland*

that buck rabbits warn their fellows by stamping on the ground with their hind feet. The sentinels set by some forms have already been mentioned.

Recognition markings have also been described in some gregarious forms, and are supposed to be a means of keeping individuals of the same species together. Many antelopes, for instance, are marked with alternating light and dark stripes or spots on the upper parts of their bodies, which may, perhaps, serve the purpose indicated. Another means of keeping communities together is afforded by the possession of characteristic odours. In the peccaries or wild pigs of South America, there is a gland on the back which secretes a fluid of unpleasant smell, at least to our way of thinking, and in sheep there are bottle-shaped glands between the hoofs, from which an odorous fluid is squeezed out on the herbage, leaving a track that can easily be followed by the sense of smell.

Descent of Man. By those most competent to judge, it is now universally admitted that the physical structure of man does not separate him more sharply from the highest apes than these, by their anatomical characters, are marked off from ordinary monkeys, and the highest apes are undoubtedly his nearest allies. It is true that man is the animal best adapted to progression in the erect attitude, as seen in the structure of his hind limbs, but this is simply a matter of degree.

It may be added that the body of a human being is quite a museum of " vestiges " handed down as souvenirs of earlier stages in evolution. Such are the troublesome " appendix " of the intestine, and a little red fold in the inner corner of the eye, which represents a " third eyelid," found in some lower mammals—*e.g.*, the rabbit.

The real differences are to be found in the power of articulate speech, and the faculty of reason associated with an exceedingly large brain. But most probably both speech and reason were both gradually evolved, just as physical characteristics have been. A course in natural history is not the place to discuss in detail so thorny a question, especially as experts are not all agreed.

Continued

Group 6
CIVIL SERVICE
15

Continued from page 1930

THE SERVICE OF THE STATE

The Advantages of the National Service. Its Scope and Departments. Emoluments. Conditions of Entering

By ERNEST A. CARR

READERS of this course will recall that at its inception the ground to be traversed was mapped out into three great provinces—the *municipal*, the *national*, and the *imperial* services. Our consideration of the first of these ended with the section on Poor Law appointments. We now turn to that distinct and very important branch of our general subject which is comprised in the National Service. It corresponds very nearly with that division which is technically known as the home Civil Service, though we have throughout this course employed the word "civil" in a less restricted sense.

The National Civil Service. For a clear understanding of this section it is essential, before reviewing in detail each of its many grades, to consider briefly the national service as a whole, and the general conditions characterising it. We must understand something, for instance, of the average prospects it offers, the nature of the duties involved, and the provisions existing as to the sick pay and the retiring allowances of Government servants. And it is necessary, also, to have a clear comprehension of the methods by which appointments are filled, and the requirements in respect to education, age, and health. The prevalent system of open competitive examinations, in particular, is of supreme importance to prospective candidates.

We may define the national service in a phrase as the sum total of all non-fighting posts—except in India and the Colonies—which are held directly under the State and remunerated from public funds. This definition will be seen to exclude municipal servants, since their offices are held under local authorities of various kinds; but it is wide enough to embrace all other public servants of every degree. The Secretaries of State and their youngest messenger lads, our representative at Berlin or The Hague and the modest Customs officer who searches his baggage for smuggled spirits or tobacco when that dignitary lands at Dover or Harwich—all these, with every Government official of intermediate grade, are equally members of the national service.

Numbers and Constitution. This great army of State servants numbers between 50,000 and 60,000 of all ranks, and is entrusted with the execution of all civil affairs which are of national interest as distinguished from merely local concerns. The importance and varied nature of the duties thus performed cannot readily be estimated. With the giant work of the postal and telegraph services and of our preventive departments we all are more or less familiar; but few of us realise, probably, how much labour is involved in such functions as our prison system and courts of law, or the civil direction of the Army and Navy. To these we must add the great and grave departments of State, controlled for the most part by parliamentary secretaries, which are concerned either with the administration of internal affairs or with the problems of international relations.

Scope of the National Civil Service. In the former category we may place the Home Department and the Treasury, and in the latter the Foreign Office, Colonial Office, and that of the Secretary of State for India. In the course on the municipal service we saw that two further State departments—those of the Local Government Board and the Board of Education—exercise a central and salutary control over the actions of local authorities. Other special functions are exercised by the Board of Trade, the Patent Office, Royal Mint, and a host of offices, great and small, with whose very names the general public is unfamiliar, but whose duties, nevertheless, are of national importance. And, save for certain technical posts in the Admiralty and War Office which are reserved for members of the combatant services, every Government office is staffed entirely by officials of the national service.

In a few exceptional instances—as in the metropolitan police courts, whose officers are paid partly out of the police rate—the salaries of Government servants are derived in part from local funds, but in the great majority of cases the sources of income are wholly national. The cost of each department, including salaries, is estimated annually in advance, and the total amounts thus calculated are submitted to the House of Commons every year and appropriated out of the nation's revenues by a parliamentary Vote on Account.

Salient Features. The national differs from the municipal section in several material respects. In the first place, as befits a Government institution, it is marked by a completeness and uniformity of system almost entirely wanting in the municipal world. Instead of conditions altering in greater or less degree with every change of district, the State affords its employees of each grade, throughout the country, clearly defined and practically unvarying terms of service, including rates of pay, amount and frequency of increment, and so forth. This is not entirely an advantage. Local bodies, in exceptional cases, may mark their sense of official zeal and devotion by a liberality unknown under the rigid rules of Government service. On the whole, however, a fixed and adequate

scale of remuneration is preferable to dependence on the uncertain views of a council or board of guardians.

This uniformity of method extends also to the conditions under which the Government service may be entered and left. For admission to each of the main grades of appointment certain regulations are framed which are bindng on all candidates alike, and every permanent official is subject to the same provisions as to pensions and gratuities on retirement.

A Clerical Service. A further distinction may be based on the nature of the duties in this service. The municipal section, as we have seen, comprises engineers, inspectors, chemists, police officers, firemen, nuises, and a great many others whose functions are practical and executive rather than clerical. The national branch, as viewed from the candidates' standpoint, is in the main an assemblage of clerks of various grades. There are many exceptions, it is true, notably in the Excise and Customs and Prisons departments, the inspection of mines and factories, and certain technical posts in the non-combatant staff of the Royal Navy. But, speaking generally, the work of the national service is clerical throughout.

The distinction is worth considering. It is evident that such a service, as compared with one which is largely executive, will include fewer posts for which some degree of education is not imperative. On the other hand, it affords less scope for the skilled expert and the able administrator. A clerk, however capable he may be, can hardly expect to find in his calling the same opportunities for personal distinction and rapid advancement as may await a clever analyst or architect, or a trained engineer who is willing to incur the grave responsibilities involved in carrying out great public works.

Such considerations lead us to expect in the national service precisely the features which, in fact, it displays. These are moderate but progressive salaries, promotion usually dependent on steady service, light and regular duties, and a small proportion of distinctly subordinate posts.

Lot of the Government Clerk. To a man of reasonable ambitions, who is repelled by the uncertainties and stress of commercial life, the national service, with its assured income and liberal leisure, offers many attractions. The Government clerk enjoys, indeed, a degree of consideration and dignity but rarely attained by his colleague in commerce. He is generally housed in a spacious and comfortably appointed building, as befits a servant of the State. The Foreign Office, Home Office, and other great departments in the West End of London, are among the finest structures in that region of fine buildings. During the seven hours which constitute the average official day, work proceeds at an unhurried and equable pace, with due regard to the sanctity of the luncheon interval. The character of that work naturally varies with the various offices. Usually it includes correspondence or bookkeeping, indexing and docketing documents, compiling statistics, preparing reports, and similar clerkly duties. In the higher ranks the work, while of the same general character, is more responsible, and involves the supervision and control of the subordinate staff.

Such are the conditions normally prevailing in the average Government office. Certain busy, important departments, however, are disagreeable exceptions to the rule. The General Post Office, throughout all its branches, is a notorious instance in point. It employs an enormous staff of clerks and other workers on duties that are generally monotonous, uninteresting, and performed at high pressure. The outdoor officers of the Inland Revenue and Customs offices, again, are required to work under irksome conditions of exposure and irregular and often protracted hours.

Vacation and Sick Leave. In respect of leave and sick leave the State is unquestionably a liberal employer. Higher class officials are entitled to six weeks' holiday yearly, which is extended after ten years' service to eight weeks. For officers of intermediate rank the annual leave varies between three weeks and a month, and only the distinctly subordinate grades are restricted to shorter terms of from ten to eighteen days. The provisions as to sick leave are as follows. Members of the permanent staff receive full pay while absent on account of ill-health, until they have been away for six months continuously. If still unfit for duty, they may then be placed on half-pay for another six months. At the end of this latter term their case is specially considered, and they are usually either granted further leave without pay or called upon to resign.

Such considerate treatment is rare indeed outside the Government service. How beneficent the system proves in practice was illustrated by the case of a colleague and friend of the writer's, who, after a few years in a State department, developed somewhat serious lung trouble. Dependent as he was upon his salary, he might have fared disastrously in other employment. But the authorities promptly granted him six months' absence on full pay. He was thus able to make a voyage round the world, returning to England completely restored to health.

Remuneration. The national service comprises appointments of a great many grades. A special feature of our next article will be a "conspectus," or general table, showing the range of salary and other particulars in respect of each rank. For the present it will serve to group these posts approximately into three broad divisions.

Of these the first includes the highest clerical and administrative offices, relatively few in number and keenly contested. Starting at £150 or £200 a year, they rise rapidly to £700, £800, £1,000, or higher. In the second flight are the mass of ordinary clerical positions, with initial salaries varying from £70 to £100, and advancing by moderate increments to £350, £400, or occasionally £500. Last in rank we must place the post-office telegraphists and sorters, inferior clerks, messengers, and other subordinate officers, whose prospects are bounded

by a slowly attained maximum of £150 or £200 a year.

Promotion. Prospects of promotion vary a good deal with the different offices, some of which are conspicuous for the chances they afford while others are as notably wanting in that respect. Generally, the traditions of the Service are opposed to the speedy promotion of juniors. This vexed question was briefly discussed in our opening article [page 79]. As was there pointed out, the authorities, while avowedly solicitous to reward ability, in practice make advancement by seniority a rule from which they are very reluctant to depart. Rarely is a deserving junior specially promoted. He must generally wait until all the men before him on the list have been given their "step" in turn. Hence, though a great many higher posts are filled from the subordinate ranks, and the chances of eventual promotion are consequently good, advancement comes with halting feet. The natural result is a certain degree of discontent among eager, ambitious young officials whose road to promotion is blocked by a line of stolid and not over-strenuous elders. For men of the requisite ability and resolution, however, there is a more direct method of advancement than awaiting the special recommendation of a chief or the translation of every senior officer. This short cut consists in competing while in the Service for a post of higher value—a course which is facilitated by the ample leisure left at the close of the official day.

Pensions. Among the attractions of State employment is the prospect of a pension when one's term of duty is ended. The system in force is a liberal one, and is so simple in principle that it may be summarised in a few words. Members of the permanent staff who are invalided before completing ten years' service are not entitled to claim a pension, but may receive a gratuity of one month's pay for each completed year. Officers of ten years' standing and upwards, if certified unfit for further duty, are entitled to a life pension proportionate to their position and length of service. This is calculated upon the scale of one-sixtieth of the officer's salary for every year of service up to a maximum of 40 years. If invalided after 15 years, for example, the superannuation allowance would be $\frac{15}{60}$ths, or a fourth of the salary. After 20 years it would be $\frac{20}{60}$ths, or one-third; after 30 years $\frac{30}{60}$ths, or a half; and after 40 years (or more), $\frac{40}{60}$ths, or two-thirds, which is the *maximum* proportion attainable in any event.

At the age of 60 retirement is optional, and at 65 it is compulsory. Thus, an officer entering when 20 years old and reaching a post with £600 a year, can claim on his sixtieth birthday a pension of £400. Five years later he would be obliged to retire; and since not more than 40 years' service counts towards a pension, his superannuation would not be increased. If, however, he entered at 25, the pension payable at 60 would be only $\frac{35}{60}$ths, or £350 a year, while by continuing at his post until 65 he would complete the 40 years' service requisite for the full allowance of £400. Officers serving abroad in unhealthy districts are entitled to count every two years thus spent as three years for pension purposes; and for those who are injured in the course of their duties special provision is made.

Government servants are not liable, as we saw that Poor Law officers are, to any deduction from salary on account of pension.

In one respect only does the scheme we have outlined lend itself to criticism. This is the absence of any provision for the family of an officer dying "in harness." The question has recently been investigated by a Royal Commission, and there is good reason to hope that as the outcome of its recommendations a year's salary at least will be payable in that event, the general pension scale being slightly reduced to meet this extra expense.

How Vacancies are Filled. From the figures quoted as to the number of Government officials it is evident that vacancies are constantly arising. Estimating the average official term at 20 years, it follows that some 3,000 appointments must be made every year to replenish the losses occasioned by resignations and deaths. For us, as candidates actual or potential, the supreme question is just this: under what conditions are those 3,000 vacancies filled?

In the bad old days of patronage, down to the middle of last century, such posts were in the gift of the Ministers of State, who appear to have bestowed them with less regard for the needs of the Service than for the wants of their importunate friends. It is from this age that the tradition dates which depicts the average civilian as an incompetent and supercilious lounger. If such a portrait be now admittedly libellous and out of date, it is wholly because the patronage system has been gradually replaced, meantime, by one which makes ability, education, and health the passports to the Service. At first nominated candidates were required merely to furnish proofs of their fitness to serve. But in 1870 a radical change was introduced, which, by attracting capable, well trained men to the Service, has done more than anything else to promote its efficiency.

Open Competition. This sweeping reform consisted in throwing open the majority of Government appointments to the unrestricted competition of British subjects of fitting age, health, and character. The system proved instantly successful and is in vigorous operation to-day. Under the direction of a special department—the Civil Service Commission—open contests are held for posts of the various grades as occasion requires, and existing vacancies are filled by appointing the candidates who take the highest places.

From the standpoint of would-be Government employees the importance of the reform thus effected can hardly be overstated. Open competition fulfils Napoleon's boast of opening a career to talent, however lacking in influential friends its possessor might be. The highest positions in the service of the State are placed

within reach of any youth of the requisite ability and education, no matter how humble in origin or poor in purse. And this tendency to democratise the Service, already strongly marked, will become still more accentuated in the near future. Hitherto, despite the absence of caste barriers in these contests, the degree of education necessary to compete successfully for the most valuable posts has proved, in practice, almost prohibitive for candidates below the middle classes in position. But with the elaborate system of scholarships recently devised by the County Council, extending from the elementary school to the University [see page 1677] that disability will be minimised, and the labourer's son may meet the scion of nobility in fair and honourable rivalry for the prize of a lucrative career under the State.

Open competitions for the various vacancies are announced from time to time in the "London Gazette" and the leading newspapers. The advertisement of the Examining Body appears in the Thursday issue of most of the London morning papers, and may usually be found below the theatrical announcements on the centre sheet. Detailed particulars of any of the examinations there named, and of the appointments to which they relate, may be obtained on application to the Secretary, Civil Service Commission, Burlington Gardens, W.

Nominations. While public competitions form the principal means by which the national service is recruited, a certain number of posts (some of which are distinctly valuable) are still reserved for the nominees of leading officials. A list of such appointments, and of the persons in whom the right of nomination is vested, will be found in the general table appearing in the next instalment. The usual practice is to name several candidates to compete among themselves for each vacancy. Contests of this character are officially styled "limited competitions," and are not advertised. In some instances, nominations for superior posts are given to subordinate officers as a reward for ability and zeal. A few technical and minor positions are filled without competition, the person designated having only to pass a qualifying examination.

Since appointments as valuable are to be won by open as by limited contests, it may be supposed that a nomination is of little service to the candidate. This, however, is a gravely mistaken view. In the arena of public competition the fight for success is very keen. There are sometimes ten or fifteen candidates for every vacancy, and occasionally the proportion is as high as 20 to 1. But within the select circle of the nominated, no such stress exists, and the competitors usually number from three to five for each post. Aspirants who can obtain a suitable nomination should therefore on no account neglect to secure it.

Age and Health. Each class of appointment, as we shall see hereafter, has its own age limits as well as its special examination subjects. Except for certain subordinate work in the Post Office, the earliest age at which a permanent footing can be gained is 17, and there are few posts for which a candidate can compete after passing his 25th birthday. By a valuable provision, however, persons who have served in the Army or Navy, or as Volunteers on military duty, may deduct from their actual age any time so spent. And under certain restrictions a similar allowance not exceeding five years may be claimed by members of the national service itself when competing for higher posts.

After succeeding at the educational contest, every candidate is required to pass a medical examination before appointment. As is imperative in a service making such liberal provision in case of illness, this is a fairly severe test, and is particularly stringent in the case of foreign service. In the Customs good eyesight is insisted upon, but for other departments a moderate degree of short sight is not a disqualification. The Civil Service Commissioners mention the following as among the commonest causes of rejection on medical grounds: poor physique, delicacy of constitution, diseases of the heart, lung, eye and ear, paralysis, epilepsy, nervous complaints, and diseases of the liver and kidneys, especially persistent *albuminuria.*

No aspirant who is dubious of his health can afford to disregard this question. The Commission absolutely declines to sanction an official examination of the health of any save successful candidates. On the other hand, rejection on medical grounds at the eleventh hour is a cruel possibility in such a case. Any competitor having reason to fear such a contingency would therefore do well to apply to the Secretary of the Civil Service Commissioners for their "Memorandum respecting Medical Examinations," which is explicit enough to enable any competent doctor to pronounce on the candidate's ability to pass the medical test.

Fees. The examination charges made to competitors vary from 1s. up to £6, according to the salary ordinarily obtainable in the appointment sought. A £100 maximum, for example, involves a fee of 7s. 6d.; for £200 it is 12s. 6d.; and for posts rising severally to £300, £350, and £450, the corresponding fees are £1, £2, and £4.

Continued

Group 13
GEOGRAPHY
15

Continued from page 1976

AUSTRIA-HUNGARY & BALKAN PENINSULA

States of Austria-Hungary. Danubian Plain. Alpine and Carpathian Provinces. Climate, Products, and Physical Features of the Balkan States

By Dr. A. J. HERBERTSON and F. D. HERBERTSON, B.A.

The Danube Basin. All the regions hitherto described are crossed by rivers flowing to North European seas. The only remaining region, the Danube basin, is cut off from the rest of Germany by the Central Highlands and is drained to the Black Sea.

The sources of the Danube in the Black Forest are quite near the Rhine, but the two rivers immediately diverge. The Danube flows east along the base of the Swabian Jura, receiving, among other tributaries from the Alps, the Iller, with Ulm at its confluence, the Lech, on which is the old trading town of Augsburg, the Isar, on which is Munich (München), the capital of Bavaria, and the Inn from the Tyrol. The Inn enters the Danube among magnificent scenery, and at its confluence is Passau, the frontier town of Austria. Into that country we shall next follow it.

What Austria-Hungary Is. Austria-Hungary is a dual monarchy, consisting of the empire of Austria and the kingdom of Hungary, governed by an Emperor-King.

The Austrian Empire (116,000 sq. miles) consists of (1) Bohemia, Moravia, and Austrian Silesia, all in the Central Highlands; (2) the Danube archduchies of Upper and Lower Austria; (3) the Alpine duchies of Tyrol, Salzburg, Styria, Carinthia and Carniola; (4) the Dinaric lands of Istria and Dalmatia, on the Adriatic; (5) the Carpathian lands of Galicia and Bukovina, on the northern foreland of the Carpathians; and (6) the protected Balkan States Bosnia and Herzegovina, north of the Balkan peninsula, technically part of the Turkish Empire, but administered by Austria [95].

95. THE STATES OF THE AUSTRIAN EMPIRE

In the midst of these is Hungary (126,000 sq. miles), the plain of the Danube, surrounded in the north and east by the Carpathians and the Transylvanian Alps, the latter forming Transylvania, and in the west by the bare limestone mountains of Croatia-Slavonia.

The Lack of Unity. Many different regions are thus united, occasionally, as in the case of Hungary and Bohemia, corresponding with geographical conditions, but often determined by merely political considerations. Austria-Hungary is, therefore, geographically unstable. It is also racially unstable. The different elements in the population—German and Slavonic in Austria; Magyar, Romanian, and Slavonic in Hungary—contend for mastery, and their political union is attended by constant friction.

The Danube in Austria. A region so vast and diverse has too many varieties of climate, products and occupations to be described as a whole. What unity it has comes from the great Danube, which enters Austria at Passau, where it receives the Inn, its only tributary from the Swiss Alps. Below Passau it flows between the Alps and the Bohemian Mountains, forming the Austrian Gate, at the eastern end of which Vienna is built. A traveller thus describes the scenery of the Austrian Gate.

"The river spreads out into a lake, completely closed in by the forest-clad amphitheatre of mountains. On and on for many long miles through scenes of the most romantic beauty, past mountains clothed from top to bottom with dark pines, and ruined castles peering out from amidst the fir forests on the summits of precipices, and sequestered ravines where nestle small villages with overhanging roofs and wooden balconies, and side valleys, up which you see waterfalls and hanging bridges. Scene succeeds to scene of romantic and even awful beauty."

At Vienna the Danube is a magnificent river, rolling across a plain shut in to the south by spurs of the Styrian Alps projecting towards the little Carpathians, offshoots from the main range. Between these the river flows in a gorge known as the Hungarian Gate, where the Hungarian town of Pressburg is built.

A Magnificent View. All this is easily made out on the map, but it is thus a traveller translates the map's abstractions into realities: "To the east downwards the plain sinks into the horizon, and the towers of Pressburg, and even the foremost heights of the distant Carpathians, are discernible. To the south-west are offsets from the ridges of the Styrian Alps which form the rapids of the Danube. To the west the country rises from vineyards and orchards to precipices, forests, and mountains, the commencement of the Alps. To the south the lofty snow-clad summits of the Styrian Alps, embracing one side of the plain on which Vienna stands, and sending out promontories abruptly to the Danube, close

96. AUSTRO-HUNGARIAN EMPIRE

the circle. In the midst of this vast panorama lies in full view the city of Vienna, with its cathedral and lofty spire rising against the sky; and far the most striking part of every view of which it forms part, the Danube, the monarch of European rivers, rolling its rapid and mighty stream." Just above Pressburg comes in the March from the Moravian Gate, flowing between the Bohemian Mountains and the Carpathians.

The Hungarian Danube. We are now in Hungary, with the Alps and Central Europe receding behind us. Pressburg is the gate of Eastern Europe, the direct road to that sea whose waters wash the shores of Asia. In the fertile plain which the Danube next crosses, the Raab comes in on the west from the Alps, and on the east tributaries descend from the Carpathians, which are broadest in the Hungarian Ore Mountains. Between these and the Bakony Forest on the west, at whose southern base is Balaton, the largest lake in Austria-Hungary, the river flows, and is turned south by the eastern spurs of the Bakony Forest. On these, the last heights in the Hungarian plain, is Budapest, the capital, a double city, Buda on the high west and Pest on the low east bank, together forming a city magnificent in natural beauty and architectural splendour.

The Plain of Hungary. Before us stretches the lake-like river, studded with wooded islands, and a vast plain loses itself on the distant horizon. Hundreds of rivers water it, spreading their rich sediment over it in every flood. On its illimitable pastures are bred famous horses, and tens of thousands of cattle, sheep, and swine. It is, in fact, part of the great Eurasian steppe, and its Magyar inhabitants are true to the blood and the pastoral occupations of their Asiatic ancestors who centuries ago conquered a country so well suited to them. Elsewhere, ploughed fields, golden in summer, stretch far as eye can reach. The villages, with their orchards of plum and pear, and their shady acacias, are dotted about the plain, far apart, but large and prosperous. Through this land of green and gold the Danube flows south to meet the Drave, which has come down from the Tyrol and along the eastern margin of the Croatian Mountains, behind which are the blue Adriatic and the Hungarian wheat and flour port of Fiume. The united river keeps the direction of the Drave, receiving the Tisza, or Theiss, flowing from the Carpathians through corn lands and the famous vineyards of Tokay. Its last great tributary is the Save, which has come 700 miles from the Alps of Carniola and along the north-west margin of the Balkans; it receives the Drin from the south, the boundary between Bosnia and Servia, the latter of which fronts Hungary across the Danube. The Servian capital, Belgrade, is built at the confluence of the Save, and 50 or 60 miles lower the Danube forces its way between the Transylvanian Alps and the Balkans, in a series of grand defiles called the Klisura, terminating in the rapids of the Iron Gate, now made navigable by blasting and canalising. Here, at Orsova, it leaves Hungary.

The Climate of Hungary. In Hungary we begin to experience the continental climate of Eastern Europe. The summers are hot, the winters very severe, except along the Adriatic coast. The products have already been described. Wheat, and timber from the forests of the highlands are the chief exports.

The Mountains of Hungary. So vast and rich are the plains that we often forget the mountains of Hungary. For 600 miles on the north and east the country is enclosed by the Carpathians, 150 miles broad at their broadest. The finest scenery is in the Tatra, where granite peaks, 8,000 feet high, rise above lovely lakes. Oak, beech, and pine forests clothe the mountain side, with bear and wolf lurking in their unknown depths. Below are jewelled meadows and terraced vineyards. Minerals, such as gold, salt and petroleum, are abundant. The occupations are mining, forest industries, cattle-rearing, and agriculture.

The mountain-girt Transylvania is watered by tributaries of the Maros, which breaks west through the mountains to the Danube. The capital is Kolosvar, or Klausenburg, a university and manufacturing town.

Croatia consists of bare limestone mountains, rising above the Adriatic, and of the fertile but marshy land between the Drave and Save. The bare, treeless mountains are "furrowed, pierced, and riddled into caverns, clefts, and gullies, valleys that have no outlets, and rivers without perceptible sources." This region is called the Karst. Agriculture and cattle-rearing are both backward. The capital is Agram.

To the north-east of Croatia is the Istrian peninsula at the base of the Alps, with the Austrian port of Trieste, behind which rise the bare mountains of the Karst.

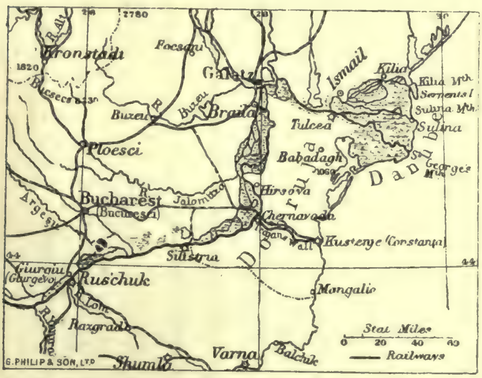
Dalmatia. To the south the Karst scenery continues in the wild Dinaric Alps, which descend 5,000 ft. or 6,000 ft. to the white towns, Ragusa, Cattaro, and others, of the Dalmatian coast. The summers are hot and dry, the winters mild and wet. Some evergreen forests remain, and on the lower Adriatic slopes the vine, olive, and orange are grown.

The Alpine Provinces of Austria. The scenery is of the Alpine type already described. The climate varies with elevation and situation. Valleys opening north and east have warm summers, but cold winters; the Adige and other valleys opening south have a climate which suits the vine and mulberry. In the higher Alps cattle-rearing is the chief occupation. Agriculture becomes important in the lower valleys and towards the Danube. Salt is abundant in the Salzkammergut, the picturesque district round Salzburg. Iron and lead are widely distributed in Styria, Carinthia, and Carniola. Besides Salzburg, the chief towns are Innsbruck, on the Inn, the capital of Tyrol, giving access to the fine rock scenery of the Dolomites; Gratz, the capital of Styria, on the Mur, a tributary of the Drave; Klagenfurt, the capital of Carinthia, on the Drave; and Laibach, the capital of Carniola, on the Save. All these rivers and towns are connected with important routes across the Eastern Alps.

Upper and Lower Austria. These lie between the Alps and the Central Highlands, forming a transition between Germany and Hungary. They are mountainous, and thinly peopled. The chief towns are Linz and Vienna, at opposite ends of the Austrian Gate.

Bohemia. Bohemia consists mainly of the basin of the upper Elbe. It possesses many natural advantages which a prosperous people are quick to utilise. The climate of the surrounding mountains is severe in winter, but in the lowlands the vine can be grown as well as cereals; also sugar-beet, for making sugar; potatoes, for food and distilling; and hops, used in brewing famous beers, especially round Pilsen. The mountains yield valuable forests, leading to paper-making and other forest industries, and cheap water-power to carry them on. Coal and iron are widely distributed, and kaolin, clay and quartz in the northern mountains make Bohemian glass and porcelain famous. Wool from the highlands, and cotton and flax brought by the Elbe are largely manufactured. Engines and railway plant are made at Prague, the capital, a city of palaces and factory chimneys, situated on heights above the Moldau. The majority of the inhabitants are Czechs, but Germans are numerous in the towns.

Moravia and Austrian Silesia. Moravia lies east of Bohemia, between the Moravian Highlands and the Carpathians. The mountains have a severe climate, but the vine can still be grown in the lowlands, as well as barley and sugar-beet. Linen and woollen manufactures are important round Brünn, the



97. THE DELTA OF THE DANUBE

capital. Silesia carries on manufactures on the Austrian portion of the Silesian coalfield. The capital is Troppau.

The Carpathian Provinces. Galicia and Bukovina are mountainous in the south, where the Carpathians rise to 5,000 ft., but fertile in the north, where they sink to the plain. The climate is severe, the country being exposed to the snowstorms which sweep over Russia. Forests cover hundreds of square miles. In the lowlands cereals and potatoes are grown, and much spirit is distilled. Petroleum and rock salt are abundant, and a miniature underground town exists in the rock-salt mines of Wieliczka, near Cracow. This, the old Polish capital, in the narrow valley of the Vistula, commanding the route to the Moravian Gate, is a handsome city, manufacturing cloth and leather.

Bosnia and Herzegovina (20,000 sq. miles). Bosnia is a land of mountains and valleys, the former clad in magnificent but unproductive forests. Much of the surface has a mere film of soil, and is only fit for pasture. In the valleys, cereals, the vine and immense quantities of plums are grown. Manufactures are in their infancy. The capital is Sarajevo. Herzegovina has the barren Karst scenery, but fertile valleys. The capital is Mostar, in the fine gorge of the Narenta.

THE BALKAN PENINSULA

The Balkan States. East of Bosnia and south of the Danube are the kingdom of Servia and the principality of Bulgaria, the latter including Eastern Roumelia. The little principality of Montenegro is south of Herzegovina. Except Rumania, and the small kingdom of Greece in the extreme south, the rest of the peninsula belongs to the Turkish Empire [**95**].

Rumania. At Orsova the Danube enters the fertile plains of Rumania, lying between the Transylvanian Alps and the Danube. These are crossed by innumerable rivers, flowing south to the Danube, the Rumanian bank of which is low and marshy. The largest are the Sereth and the Pruth. The summers are hot but the winters very severe, the temperature falling many degrees below the freezing point. Rumania (50,000 sq. miles) is an agricultural land, growing immense quantities of wheat, shipped from Galatz and Braila, near the confluence of the Sereth; also hemp, flax and tobacco. Petroleum is abundant and refineries numerous. Flour mills, saw mills, distilleries, cloth mills and tanneries tell their own tale.

The capital is Bucharest. The Danube reaches the sea by a great delta [**97**], the branch most used for navigation being the Sulina. The total length of the river is 1,800 miles.

A Transition Region. In the north of the Balkan peninsula we have the Central European climate and vegetation. The summers are warm and the winters severe. Oak and beech are the forest trees, the plum is the commonest orchard tree, and wheat the typical cereal. South of the Balkans, which curve round from the Transylvanian Alps, separating Bulgaria from Eastern Roumelia, we pass into a different region. The summers are hot, and also dry. The winters are mild, and most of the rain falls at that season.

The rainfall is often so scanty that irrigation is necessary for agriculture. To suit this climate plants develop various peculiarities. The aloe has thick, fleshy leaves, which store up moisture; the cypresses, evergreen oaks, and the bushy stone-pines have small, hard leaves, which lose little moisture by evaporation. This type of climate and vegetation is characteristic of the Mediterranean region, to which we are now passing. The fruits are the vine, olive, orange,

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fig, pomegranate, peach and apricot. The mulberry is largely cultivated to feed silkworms. Wheat is grown under irrigation, but millet and maize are better suited to the hotter, drier parts. Pulses, principally varieties of beans and lentils, are as important as root crops in Central Europe. One of them, lucerne, replaces grass as fodder. Cattle and horses, which need rich, moist pastures, give place to the hardier sheep, goats, mules and asses.

Mountains and Rivers of the Balkan Peninsula. Almost the whole peninsula is mountainous, though the mountains do not rise above the snow line. They form part of the great Eurasian mountain system already described, and are known under various names in different parts, as the Balkans between Bulgaria and Eastern Roumelia, the Rhodope Mountains or Despoto Dagh between Bulgarian and Turkish Roumelia, the Pindus Mountains in Greece, etc. In the north they are densely forested, but the forests have been destroyed in the south. Small plains, surrounded by mountains and difficult of access, are very characteristic of the whole peninsula. Roads are bad, and communication backward.

Four important river valleys must be noticed: (1) The Morava, flowing north, across Servia, to the Danube; (2) the Isker, rising south of the Balkans, and breaking through them to the Danube; (3) the Maritsa, flowing round the northern and eastern base of the mountains of Thrace to the Ægean; and (4) the Vardar, flowing south to the Gulf of Saloniki. Notice that (1) the Morava and the Vardar, and (2) the Morava, Isker, and Maritsa give through routes from north to south, and that the railways follow them.

Montenegro. Montenegro (3,600 sq. miles) is a wild land of bare limestone mountains, with a small, hardy shepherd population. The mountain scenery is of the Karst type, and agriculture is possible only in the wider valleys. The peasants' houses are often festooned with tobacco, which is of excellent quality. There are few roads, no industries, and little trade. The capital is Cettinye (Cetigne), a small, red-roofed village town in a mountain-girt plain, with a population considerably under 5,000.

Servia. Servia (19,000 sq. miles) consists of a lowland along the Danube, rising to wild mountains on the west, on the east (where the Danube breaks through spurs of the Carpathians at the Iron Gate), and on the south, where the mountains are part of the Balkan system. The valleys are generally fertile. Vast beech and oak forests feed countless herds of swine. In the clearings sheep and cattle are kept. The agriculture is often primitive, the fertile soil producing excellent wheat, tobacco, vine, and fruits. Dried and preserved plums are an important export. Much plum brandy is also distilled. The capital, Belgrade, is finely situated. "Perched on a hill, at the foot of which the Save joins the Danube, it commands westwards a wonderful expanse of sky and stream and willows, with a pale mauve distance of Servian mountains, while opposite lie the rich plains of Hungary and the little town of Semlin."

Bulgaria. Bulgaria (37,000 sq. miles) rises from the southern bank of the Danube to the crest of the densely-forested Balkans, beyond which lie Eastern Roumelia or Southern Bulgaria. In the Danube area maize and wheat are grown, but south of the Balkans we find the products of a hotter region, rice and cotton, as well as the vine and the ever-present plum. Mulberries and the silkworm are very important. In the Maritsa valley, the most fertile part contains many square miles of rose gardens, from which is distilled the famous Oriental perfume, attar of roses. Bulgaria is on the way to prosperity, and roads and railways are fairly well developed. Sofia, the capital, is a handsome modern city in a mountain-girt plain, commanding the Isker route. Philippopolis, built on isolated heights in a wide plain, is the second city. The ports are Ruschuk, a river port of the Danube, and Varna, on the Black Sea.

The Turkish Provinces. Wild and mountainous in structure, torn by racial and religious feuds, undeveloped and ill-governed, the Turkish provinces (62,000 sq. miles) are a waste instead of a garden. Both agriculture and cattle-rearing are backward, and the peasantry are poor, ignorant, and oppressed. The capital is Constantinople, built in one of the finest situations in the world, where "the Sea of Marmora, the Bosphorus, and the wide and winding harbour of the Golden Horn meet, forming, as it were, a great lake round which the city extends, rising stage by stage along the slopes of the hills, minaret and dome lifting themselves one above another against the azure sky." Commanding the entrance to the Black Sea, where Europe and Asia all but touch, this is one of the finest strategic points in the world. Another key to the Black Sea and the lands beyond is Gallipoli, on the Dardanelles. Saloniki, on the gulf of the same name, is the port of the Vardar Valley. Adrianople, on the Maritsa, strongly fortified, commands the route to Constantinople.

Greece. Greece (25,000 sq. miles), consisting of the southern and deeply indented portion of the peninsula, with many adjacent islands, is a land of mountains and small, isolated mountain-girt plains. The climate is typically Mediterranean, and irrigation is necessary in the drier parts. All Mediterranean plants are grown, but the chief export is the currant, a small dried grape. The sponge fisheries of the Ægean Sea are important. The capital is Athens, built much like Edinburgh, round a height between the mountains and the sea, with Piræus as its Leith. From Corinth a ship canal has been cut across the narrow isthmus of the same name between the mainland and the mulberry-leaf-shaped peninsula of the Morea. Patras exports currants.

Off the west coast are the Ionian Islands, all mountainous, with fertile valleys. Corfu is the most important. The islands of the Ægean are less fertile, and produce little but wine. Syra (Hermopolis), on a small island of the same name, is the centre of the Ægean trade.

Continued

Group 4 BUILDING 15 Continued from page 1955	# THE BONDING OF BRICKWORK Various Forms of Bonds. The Formation of Brick Walls. Bonding with Mixed Materials. Building and Bonding Curved Walls

By Professor R. ELSEY SMITH

IN any wall or structure not cut out of solid material, but formed of a multiplicity of parts, each of which is small in bulk compared with the wall into which it is built, it is inevitable that there must be many joints. Some of these are approximately or accurately horizontal, and some are approximately or accurately vertical. The horizontal joint may extend through the whole thickness and length of the structure, if the portions of which it is built be of uniform size and have horizontal surfaces, and this condition is met with in all brick walls. The layer of materials placed between two such level surfaces is termed a *course*. Where the size of the block is not regular, even when the beds are horizontal, the horizontal joints may not be found continuously at the same level, and this condition is met with in some forms of stone walling. [See MASONRY.] Unless some provision is made to prevent it, there is a danger that the vertical joints, like the horizontal ones, may continue throughout the wall from base to top, and while a level horizontal course is an advantage in constructing walls, a vertical joint extending through more than a single course is termed a *straight joint*, and is a source of weakness.

Effect of Straight Joints. If such straight joints extend from top to bottom of a wall, we should have, in fact, a series of small piers placed side by side having no connection with the pier on either side, except the mortar joint [**41** and **42**]. If such a pier is subjected to a load that is different from the load on the pier on either side, it may be thrust out of the line of the wall, or it may be crushed if not strong enough by itself to carry such load, or it may be caused to subside.

It is of equal importance that there should not be a straight joint in the cross-section of the wall, for if no alteration be made in planning the successive courses, a thick wall, such as that shown in **45**, would be, in fact, formed of two thin walls placed side by side, and a load that was borne on the inner half of the wall would convey none of its pressure to the outer half, and might settle down under the burden by itself, whereas a wall that is properly bonded in cross-section [**44**] will have any load that bears on a given point distributed throughout its thickness as well as along its length.

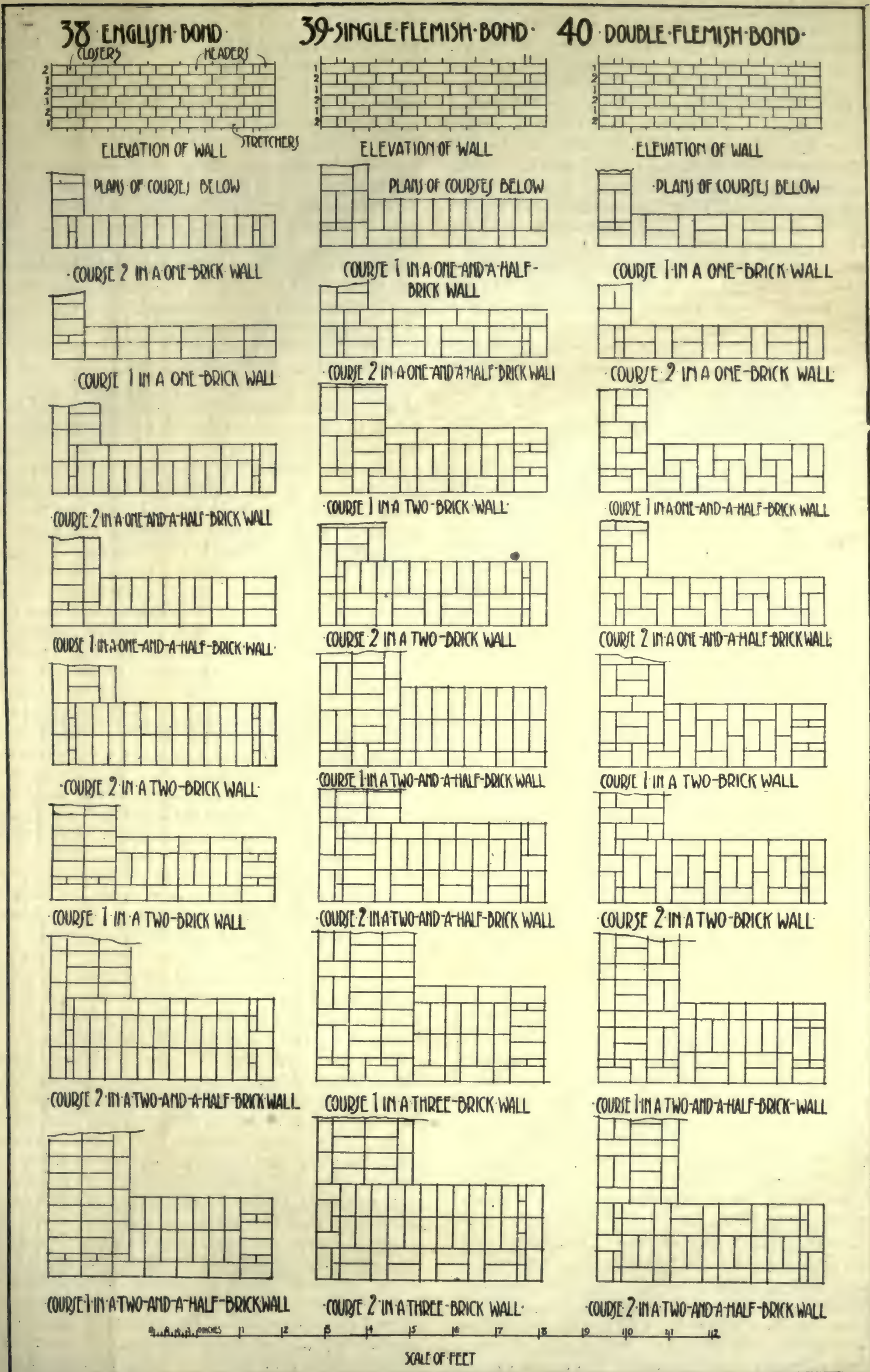
Bonding, which is used to prevent such a form of construction, is the placing of the vertical joints in every course so that they shall not, except where it is inevitable, coincide with the vertical joints in the courses immediately below it. The result of such an arrangement is that the materials in one course interlock with those in the courses above and below it. A wall is thus formed which no longer consists of independent piers, but is homogeneous in character, and the burden of a load supported at any one part of it is distributed by successive courses over an ever widening area [**43**].

Brick Bond. It is necessary to bear in mind that the bricks of any one class of manufacture are practically identical in size and shape, and that any trifling irregularities can be corrected by an adjustment of the thickness of the mortar joint. In building, therefore, with materials that are uniform in size and of such a shape that two of them, laid flat and side by side, form a nearly exact square, straight joints are very liable to occur if the work is carelessly put together; but, on the other hand, a comparatively simple adjustment, if properly carried out, suffices to obviate the danger entirely.

There are various methods of making the necessary adjustments, and various methods of arranging the bricks in a wall, and in particular on the face of the wall. Where differences in arrangements of the bricks affect the appearance of the wall, the terms applied to different varieties of walling depend on the style of bond in which they are built.

Forms of Brick for Bonding. Before describing the various forms and methods of bonding, a few general terms must be made clear. A *bat* is half of a brick broken across its length. Usually, bricks are broken so as to be one quarter and three quarters in length, or each one half, and are described as quarter bats, half bats, or three-quarter bats [**10** and **11**, page 1948]. They may be cut with the trowel from a whole brick, but in the process of carting, unloading, and stacking bricks, some always get broken, and these are utilised for such purposes, and can be cut if required to any requisite length. A *closer* is a brick cut in half in a direction parallel to its length, called a *queen closer* [**6**, page 1948], or so as to show a width of 2¼ in. on the face of the wall, and the full width of 4½ in. at the back, called a *king closer* [**5** and **9**, page 1948]. In practice, a queen closer is difficult to cut, and is not often specially moulded; two quarter bats are generally used in place of it. [See dotted lines **6**, page 1948.] A brick placed in a wall so that one of its long sides shows on the face of the wall is called a *stretcher* [**38**]; and a course consisting entirely of bricks so placed is called a *stretcher course* [**38**, course 1]. A brick placed so that one of its ends shows on the face is called a *header*, and a course consisting entirely of such bricks is called a *header course* [**38**, course 2].

Describing Thicknesses of Walls. The thicknesses of a wall may be described by the number of headers contained in its total



EXAMPLES OF BRICK BOND FOR WALLS

thickness—thus, a one-brick, two-brick, three-brick wall, etc. ; if the wall be only a half-brick thick, or is a multiple of a half-brick in thickness, it may be described as a one-and-a-half brick, two-and-a-half brick wall, etc. The convenience of this description is that it satisfactorily describes the wall for all types of bricks, not only for the ordinary sized brick [1, page 1948], but for bricks that may run a little larger or smaller. The thickness of a wall may also be described by the number of inches in its thickness—thus, a 4½ in. wall = a half-brick wall ; a 9 in. wall = a one-brick wall. A brick-and-a-half wall is sometimes spoken of as a 13½ in., and sometimes as a 14 in. wall, for by using a thick mortar joint in the thickness of the wall it may be brought up to this larger dimension. An 18 in. wall = a two-brick, and so on ; but this description is only accurate when bricks of the ordinary standard size are being employed.

English Bond. English bond, which, from a structural point of view, is the best for all ordinary walling when the thickness is one brick or upwards, is formed when in elevation ; every course is either a complete header course or a complete stretcher course [**38**]. Stretchers are never used in the interior of a thick wall, but only on the inner or outer face of such a wall. When the thickness of the wall is the exact multiple of a brick, each course will show alike on the inner and outer face of the wall—*i.e.*, either both sides will show headers or both stretchers. [See examples of one-brick and two-brick walls in **38**]. If there be an odd half brick in the thickness of the wall, the course that shows stretchers on the outer face will show headers on the inner face, and vice versâ. [See one-and-a-half and two-and-a-half brick wall in **38**.] When a wall is returned at the end—that is to say, is continued in a direction at right angles to its former direction—the course that shows stretchers on the main front will show headers on the return front, and vice versâ.

Finishing Ends of Walls. All the plans on the general sheet of bonding show walls which on the left-hand side have returned ends, and it will be noticed that in every case course 1 has closers inserted next the angle brick to bond the return wall, and in course 2 has closers inserted next the angle brick in that course to bond the front wall. It will, of course, be understood that the angle brick in course 1 ranks as a stretcher so far as the front wall is concerned, but is a header if considered in relation to the return wall.

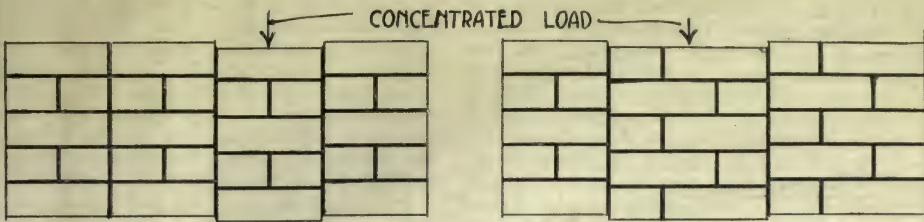
On the right-hand side of each plan the wall is shown to have a *stopped end*—that is, the wall is finished there without any return or reveal. All such ends require special attention to secure a satisfactory finish and perfect bonding.

Laying the Stretcher Course. We shall now consider the bonding of a wall which is an exact multiple of a brick in thickness, and commence with the stretcher course [**38**, course 1]. Such a course, whether the wall be one, two, three, or any other multiple of a brick thick, will have a row of stretchers extending from end to end on the outer face, and a similar row on the inner face. If the wall be one brick thick these two rows will complete the course, and the bricks in them should lie exactly side by side, so that the joints which run from back to front of the wall run straight through from face to face without any break in their length. If the wall be a two-brick wall there will be one row of headers in the interior of the wall separating the stretchers ; if it be a three-brick wall there will be two such rows of headers, and so on. But note that in all cases the headers are laid so that two are placed exactly behind a stretcher, and, whatever the thickness of the wall, the joints that run from front to back do so without any break. We shall assume for the moment that the length of our wall is an exact multiple of 9 in., and that it will therefore contain an exact number of header bricks. But, of course, this is not always the case. If our wall be not an exact multiple of a brick in thickness, but contain an odd half brick, the only difference will be that the row of stretchers on the inner face will be omitted, and a brick-and-a-half wall will have one row of stretchers on the face and one row of headers behind ; a two-and-a-half brick wall, one row of stretchers and two rows of headers, and so on.

Laying the Header Course. If this course [**38**, course 2] consisted literally of nothing but headers, we should have a wall without bond [**41**]. It is in this course that the closers are introduced ; but whatever the length of the wall, so long as there is no opening or return in it, there will never be more than two closers, one of which occurs at each end of the course. For the purpose of bonding, any interruption in the continuity of the brickwork, such as that due to the opening for a door or window, may be considered to divide a long wall up into a series of short lengths, each of which must be provided with the closers for bonding. In laying this course recollect that a header always forms the end brick.

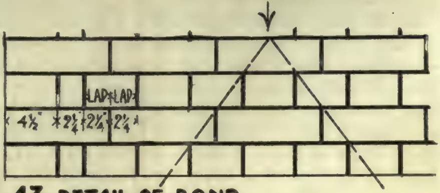
The whole thickness of the wall in this course, if it be an exact multiple of a brick, is formed with headers, and for every brick in the thickness of the wall there will be a header in the plan. In this course, as in the stretcher course, the joints at right angles to the face will run straight through from back to front in an unbroken line. If there be an odd half brick in the thickness of the wall a stretcher course is employed on the inner face.

Position of the Closer. The closer should never form the angle brick, for as it is only 2¼ in. wide, it would be very liable to become dislodged, but it must always form the next brick to the angle header. It should extend right through the thickness of the wall to be bonded from the front to the back. Theoretically, a queen closer should be used for every header in the thickness of the wall, but in practice, except for work of quite an exceptional character, two quarter-bats are used to form the closer for each brick in thickness. It will be seen [**43**] that the width of the angle header (4½ in.) plus the width of the closer (2¼ in.) make together 6¾ in., which leaves 2¼ in. between this vertical joint and the first joint in the course below, and that as the face of the next header

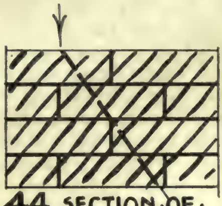


41 · ONE-BRICK · WALL · WITHOUT · BOND

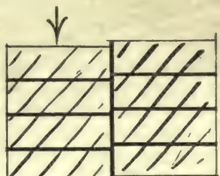
42 · 1½-BRICK · WALL · WITHOUT · BOND ·



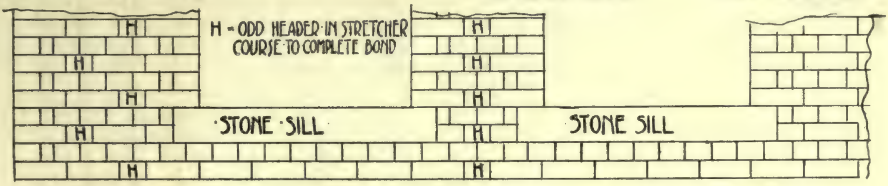
·43 · DETAIL · OF · BOND ·



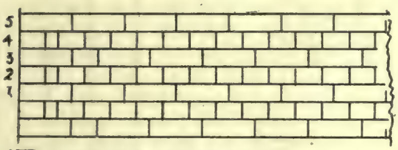
44 . SECTION · OF · BONDED · WALL ·



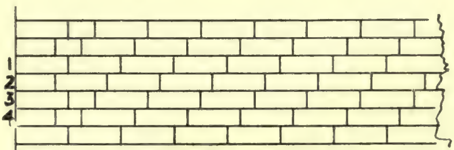
45 . SECTION · OF WALL NOT · BONDED ·



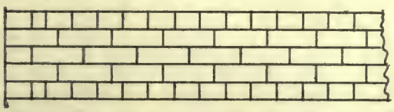
46 . WALL · WITH · PIERS · & · OPENINGS · SHEWING · METHOD · OF · KEEPING · PERPENDS ·



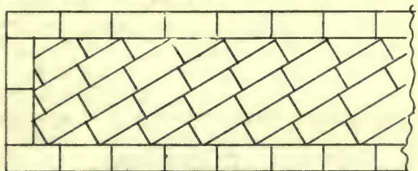
47 . ENGLISH · CROSS · BOND ·



48 . STRETCHER · BOND ·

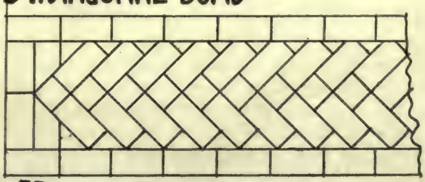


49 . ENGLISH · GARDEN-WALL · BOND ·



51 . DIAGONAL · BOND ·

50 . FLEMISH · GARDEN-WALL · BOND ·



52 . HERRING-BONE · BOND ·

EXAMPLES OF UNBONDED WALLS AND SPECIAL FORMS OF BOND

is 4¼ in., the vertical joint beyond it will also be 2¼ in. beyond the first vertical joint in the stretcher course. This horizontal distance is termed *lap*. Beyond this point, as two headers together equal in width one stretcher, the same distance between the vertical joints in the header and stretcher course will be maintained till the other end of the wall is reached, and the closer at that end is inserted to give a corresponding break and finish to the wall. A wall, whatever its height, will consist entirely of successive courses, in which the two above described will alternate regularly.

Adjusting Bond to Walls of Various Lengths. We assumed for the moment that the length of our wall was an exact multiple of a brick in length ; but this may not always be the case. Suppose there be an odd half brick in the length, the only adjustment required will be that at or near the centre of every stretcher course a half-bat be inserted [**46**]. In building with such a material as brick, if good and economical work be required, the limitations it imposes must be considered, and no short length of brick wall should be set out except as a multiple of a half-brick in length as well as thickness. In the case of a long wall this point is not of importance ; in such a wall there will be so many vertical joints that by a little *fulness*—*i.e.*, an extra amount of mortar—in the joint, or a little *tightness*—*i.e.*, a reduced amount of mortar—in the joint, some definite number of headers may be worked into its length.

Absence of Straight Joints in English Bond. In the case of a wall constructed in English bond [**38**], if the plans of the two courses of any wall be traced and placed one above another, it will be noticed that if queen closers are used there will be no position either on the face or in the heart or thickness of the wall in which the vertical joints in one course coincide with the vertical joints in the course below. If quarter-bats be used in place of queen closers such coincidence will exist only where the extra joints thus introduced occur. Such a coincidence, as already explained, forms a straight joint, and if it occurs in two successive joints, note that it will run throughout the whole height of the wall inevitably. It is the absence of these straight joints that renders English bond of such great structural utility as a more homogeneous wall is obtained when it is used than in the case of other bonds.

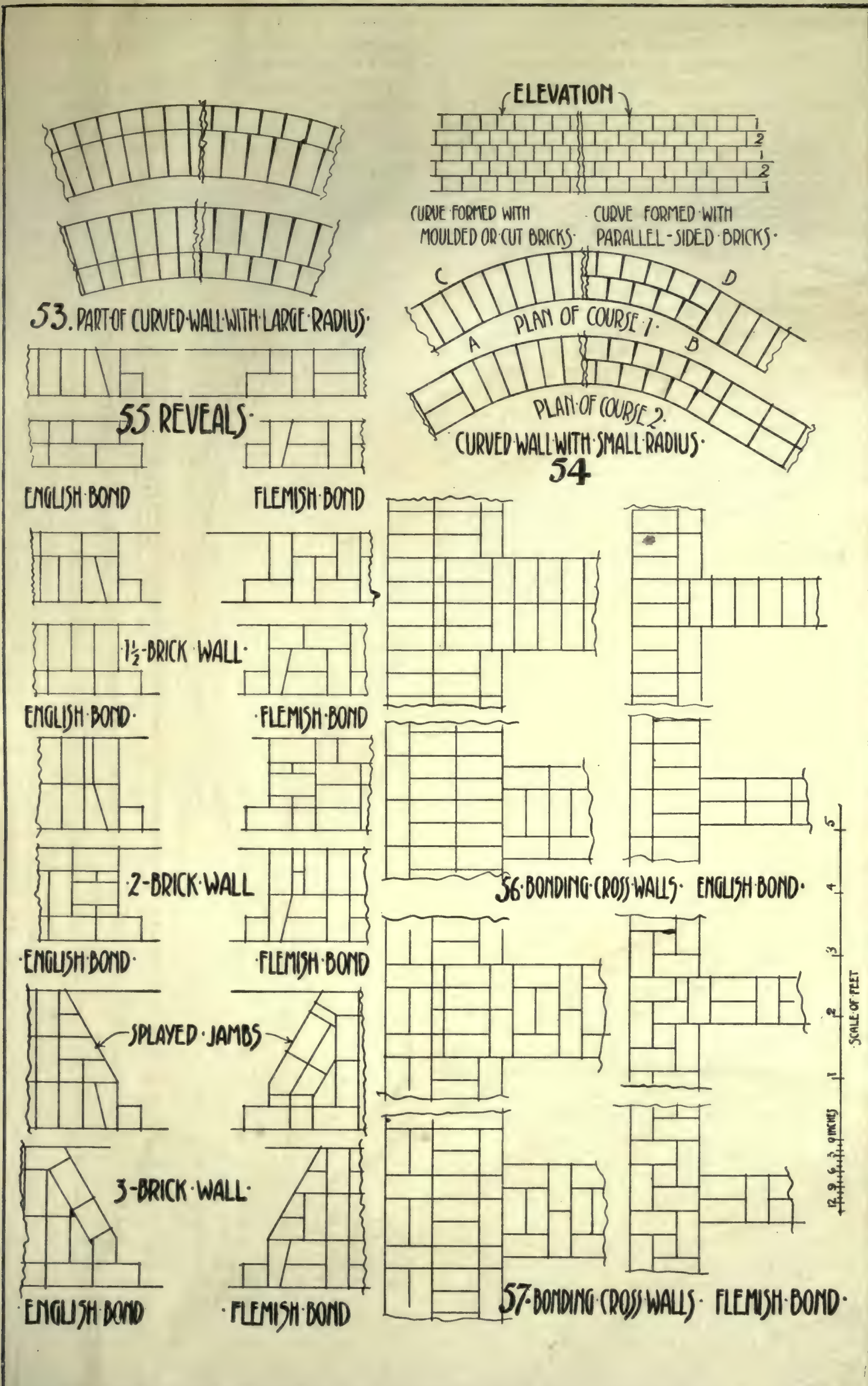
Other Styles of Bonding. On the other hand, in elevation the appearance of successive rows of headers and stretchers is considered less attractive than some other forms of bond, and where, as in the case of much domestic work, the utmost possible strength is not essential, and something may be sacrificed to appearance, a style of bond which is not quite so satisfactory structurally, but gives a different character to the face of the wall, is adopted. With a view to improving the elevation, a variation of this style of bond, known as *English cross-bond*, is sometimes adopted [**47**]. As will be seen, the only variation consists in breaking the bond between successive stretcher courses by introducing next the angle stretcher (in course 3) a single header, or bat, so that beyond this point the stretchers in this course are shifted 4½ in. to the right, and come over the centre of the stretchers in course 1. This must, of course, be provided at each end of the wall. Course 5 repeats course 1, and course 7 repeats course 3, and so on. No change is made in the header courses, and this particular bond is not inferior to English bond in strength.

Flemish Bond. Flemish bond is made use of as a further improvement to the elevation of the wall ; it differs from English in elevation in that each course consists of a header and a stretcher alternating, and at the end of a wall we find in one course a stretcher forming the end brick, and in the succeeding course a header at the end. There is not the same simplicity as to the placing of the bricks in the wall as occurs in English bond, and the number of straight joints are considerable, especially when there is an odd half-brick in the thickness of the wall. In the case of a one-brick wall the same bond must show in both faces ; in the case of thicker walls it may do so ; but, on the other hand, the use of Flemish bond may be confined to the outer face of the wall and the inner face, and the heart of the wall may be formed in English bond, to which there can be no objection if, as often happens, the inner face is to be plastered. When this form of bond is used throughout the thickness of the wall, and shows on both faces [**40**], it is termed *Double Flemish Bond* ; when used on one face only [**39**], it is termed *Single Flemish Bond*.

In this bond, as in the English bond, the closer is placed in the course which begins with a header at the end angle. This closer is carried right through the thickness of the wall ; but where a header shows in the return end, or face, to avoid using a half-bat and quarter-bat, a three-quarter bat is used, by which the same result is achieved with the saving of one joint. The sources of weakness in this form of bond are the large proportion of bats that are inevitable wherever the thickness of the wall has an odd half-brick in it when double Flemish bond is used [see one-and-a-half and two-and-a-half brick walls, **40**], and where the thickness is the multiple of a whole brick where single Flemish bond is used. [See two-brick and three-brick walls, **39**.] This is partly due to this use of bats, but mainly to the use of stretchers in every course ; if tracings of the plans of two successive courses of Flemish bond be overlaid, it will be found that, to a very appreciable extent, they coincide throughout the whole length of the wall, and that straight joints result. It is on this ground that, where possible, single Flemish bond is adopted, as this confines the use of bats and straight joints to the outer face of the wall.

One of these two forms of bond is used for most ordinary walling. There are other varieties of bond, but they are mainly required to meet difficulties that arise under certain exceptional conditions.

Stretcher Bond. Stretcher bond [**48**] is used for walls that are only half a brick in



BONDING OF OPENINGS AND OF CURVED AND CROSS WALLS

thickness. It is obvious that headers, which are 9 in. long, cannot be used in such a wall, and if any appear in the wall, they are only bats. This bond, it will be seen, consists of building entirely with stretchers; it is usually built of only two varieties of courses—*viz.*, 1 and 4 [**48**]; but more complete bonding is produced by using the four varieties shown.

This wall, by using a large proportion of bats, might be made to resemble Flemish bond; but the only occasion in which the appearance of the wall would be of sufficient importance to warrant this would be in the case of a half-brick wall formed of glazed bricks.

Garden-wall Bond. Garden-wall bond is used for 9 in. or one-brick walls, in which both faces are exposed to view. These are commonly used for separating the gardens of adjoining houses, hence the name. The difficulty met with in such walls is that though the length of an ordinary brick is given as 9 in., there is a considerable variation in practice in this length, not, perhaps, more than $\frac{1}{8}$ of an inch, more or less, but enough to make it impossible to set such bricks side by side in a wall so that both faces will be true. If one face is to be plastered, this is not important; the outer face is built even, or "fair," and if the inner is rough the plaster covers it. Adjustment can be made between stretchers, because there is a mortar joint between them, which may be made "full" or tight, as the case requires.

It is therefore necessary to pick over the bricks to be used as headers in such a wall, and to measure them against a standard length of brick, and this process means additional handling and cost. This form of bond is used in this case because it reduces the number of headers by 50 per cent. It may be employed both with English and Flemish bond. *English garden-wall bond* consists in using three stretcher courses to one course of headers [**49**]. This involves a straight joint in the centre of the wall through the stretcher courses, and this is undoubtedly a source of weakness, but such walls rarely support a heavy load. *Flemish garden-wall bond* consists in using three stretchers to one header in every course [**50**], and has the same advantages and drawbacks as English bond. Such work requires careful supervision, for even with selected headers there is often slight irregularity or distortion, and to give a good finish to the face the bricklayer is apt to cut the header into two, making it easier to set fair, but still further reducing the strength.

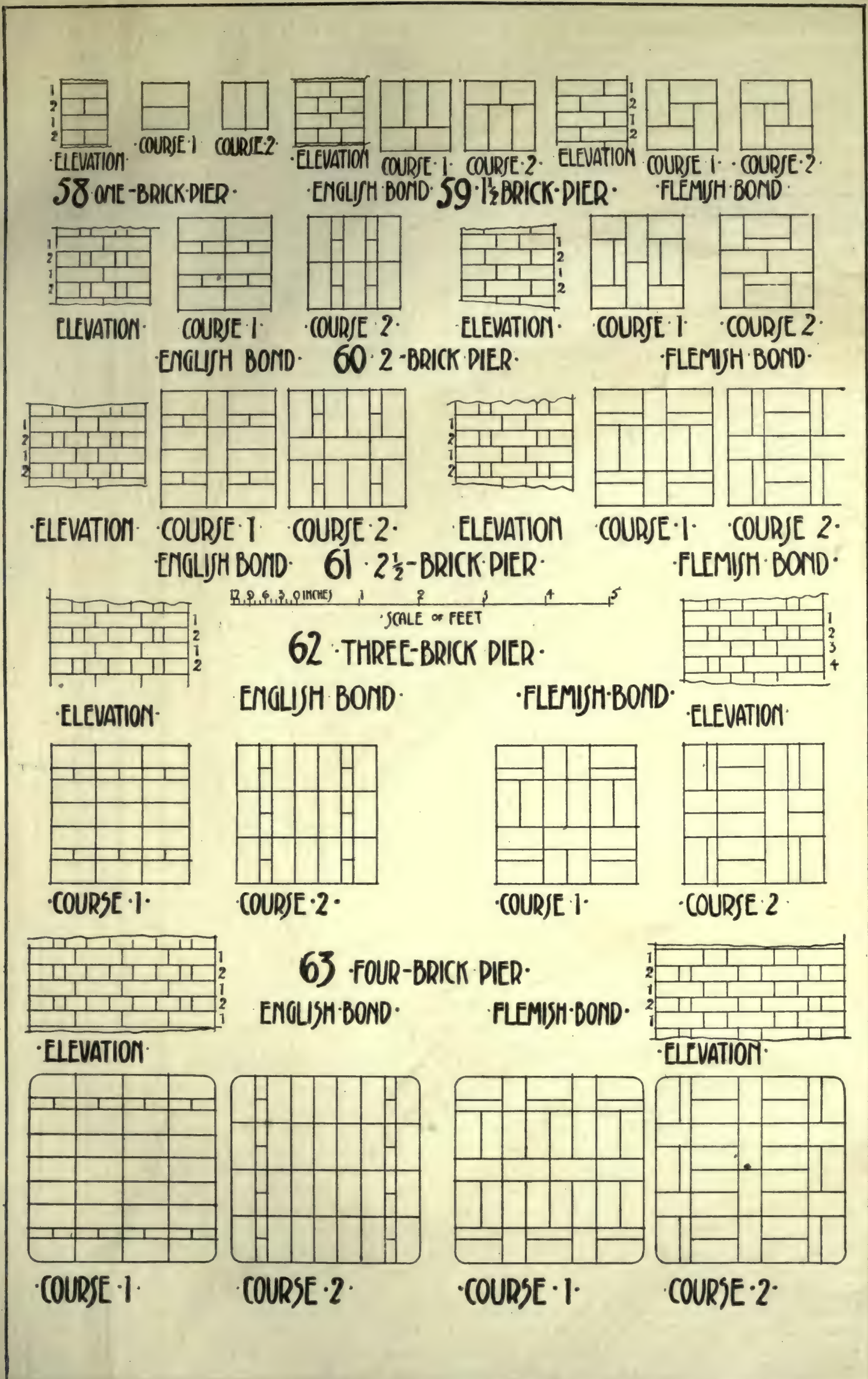
Diagonal Bond. Diagonal bond is used principally in thick walls to give a longitudinal bond at intervals. It does not show on the face of the wall; it is most satisfactorily used in the stretcher course of English bond, and is not employed in every such course, but at intervals of, say, six or eight courses. It consists in filling in the heart of the wall with bricks laid diagonally, as shown in **51**. The small triangular spaces between the facing and the diagonal work are filled with pieces of brick, roughly cut, and mortar. The bricks shown here are inclined from left to right. The next time that such a course was used they should be laid with an inclination from right to left, so as to vary the bond as much as possible.

Herringbone Bond. Herringbone bond is used in the same way as diagonal bond, and with the same object, the only difference being that the filling in is arranged on plan in the form known as *herringbone* work [**52**].

Walls Built Circular on Plan. The work hitherto described is adapted to walls that are built in straight lines, but sometimes walls must be laid on a plan that is not straight but curved. If the radius be large, and the curvature in consequence flat, the wall may possibly be built with one of the bonds already dealt with; but if the radius be short, and the curve rapid, this will be impossible.

In such a case the ideal plan is, of course, to have bricks that are purposely made with the faces formed to the required curve and the sides of the bricks converging so as to form what in an arch would be called a *voussoir-shaped brick.* This is costly; and for most work a sufficiently good appearance may be given by using ordinary bricks, provided only *headers* are employed. Such bricks will not form a true circle; but unless the radius of the curve is very small, the form will approach closely to a curve. It is essential that no stretchers be used and every course consist solely of headers; and the term *Header Bond* is applied to it. Such a piece of curved work rarely stands alone, and is used to connect two straight pieces of walling, and the bonding of the two courses is formed by continuing the bond already existing in the walls. Fig. **54** shows a wall quadrant on plan with a rather short radius, and 9 in. thick. It will be observed that the distance from A to B on the concave face of the wall is appreciably less than that from C to D at the back, and if ordinary parallel-sided bricks are used, the mortar joint must be kept fine on the face and full at the back to adjust this difference. Better work is produced by rough-cutting the brick to a *voussoir* shape, or by rubbing it accurately to such a shape, as shown on half the illustration; but this increases the cost. With the small radius illustrated the use of headers would require very wide joints at the back, and two courses of half-bats are shown. Bonding irons may be used to tie the inner and outer face together. Fig. **53** shows a wall one-and-a-half bricks thick, with a curve of a larger radius. In this case it will be noticed that either on the inner or outer face of this wall a row of bats is inevitable—with a curve of such large radius, very good work may be produced without cutting or rubbing the bricks—but the joints from front to back of the wall will not in this case be in a straight line. In this illustration the wall is shown formed on the right-hand side with parallel-sided bricks, and on the left with cut or rubbed bricks.

Forming Reveals. The method of forming stopped ends has been indicated, and we must now consider those cases in which a wall has to be finished with a *reveal.* This is a short return usually $4\frac{1}{2}$ in. on the face, but sometimes 9 in. or more, which projects beyond the



BONDING OF BRICK PIERS

end of the wall so as to form a rebated jamb, to allow of a door or window-frame being inserted behind it. Special attention must be paid to its bond, and it is in connection with this work that the king closer comes into service. The half-bat at the end of the header course is a source of weakness, and the use of the king closer next to it is some compensation. The methods of bonding reveals in ordinary walls of various thicknesses are shown [55] for both English and Flemish bond.

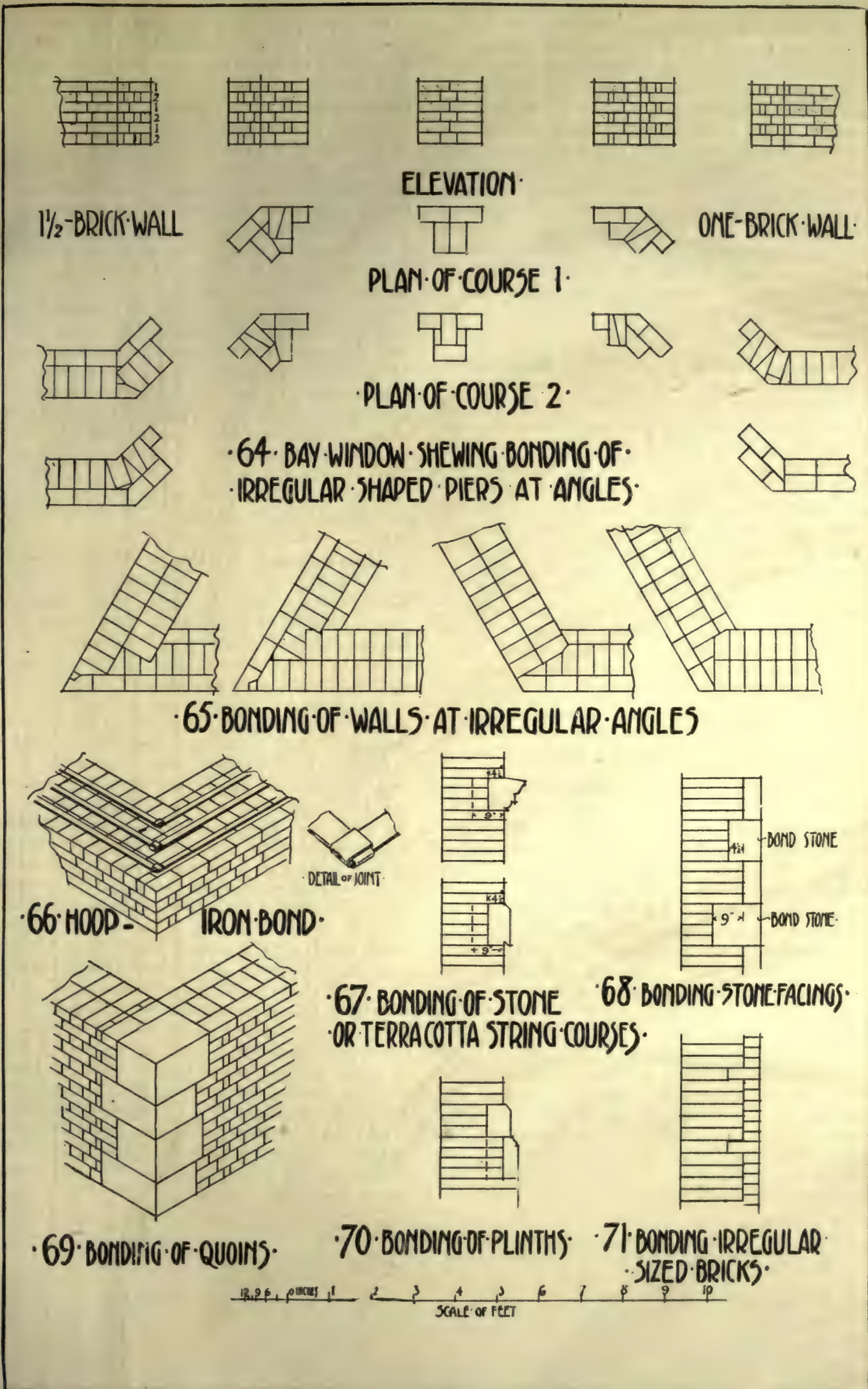
Bonding of Cross Walls. In addition to return walls, which have been already described, *cross walls* are frequently employed. These are walls starting from the internal face of the main wall at right angles, and they must be bonded to the main wall equally with a return wall. This is usually arranged for by building in the whole thickness of the cross wall at every alternate course to an extent of 2¼ in. into the main wall, the intermediate course of the cross wall merely abutting against the main wall [56 and 57].

Bonding of Piers. Piers intended to carry concentrated loads may be either attached to a wall or may stand alone and detached. In the former case the bond used in the wall will apply to the pier, and it will be treated as a short length of a thicker wall. So, also, in the case of a rectangular detached pier, it may be considered as a short length of wall with two stopped ends; but in the case of square piers a special treatment is usual, to secure proper bonding. Such piers may be constructed either in English or Flemish bond; the former is preferable where great strength is required. In all square piers the extent of closers required for bonding bears a larger proportion to the total area of the pier than in the case of a wall of the same actual area; in piers of less than three bricks this proportion becomes very extensive. It is an element of weakness in them, and all piers require very special care in construction to ensure that the joints are all well filled, and where Flemish bond is used queen closers should be employed and not quarter-bats. A pier one brick square can be formed only of two stretchers in one course and two headers in the next [58]. A pier one and a half brick square may be formed in English bond with two three-quarter bats alternating with three headers, but some extent of straight joint is unavoidable [59]. With Flemish bond it is necessary to use a bat as a core or centre for all courses, and a straight joint occurs all around it. With piers two bricks square and upwards the bonding is more satisfactory. Examples are shown of piers in both styles of bond up to four bricks square; one pier [63] is shown formed with bull-nosed bricks at all four angles. Various examples are given of the method of bonding various small and irregular shaped piers such as occur in the angles of bay windows [64] and similar situations; they should be constructed in cement mortar, to secure the utmost possible strength. As in the case of small piers, they involve the use of a large proportion of bats and of irregular pieces of brick. Such piers, as a rule, are of no great height, and cannot be expected to carry anything but quite a light load.

There are many situations in which a return wall is not at right angles to the front wall. When this is the case it is termed a *squint* angle, which may be either acute or obtuse. Here, also, special attention must be paid to the bonding, and no regular rules can be given for the construction of such angles, as the methods vary with the inclination between the two walls. Examples of such angles are given [65], and it is important to bear in mind that as few small pieces of brick as possible should be used. Whole bricks, wherever possible, or bricks with only the angles cut off, are the best. In the case of obtuse angle walls squint bricks [7, page 1948], of which the longer side is 6¾ in., may often be used in place of using closers, and, when possible, this is advantageous. A bird's mouth [8, page 1948] is often also useful for the inner face of an obtuse angle, but such bricks are not easy to cut, as the small angles may be split off. It is advisable, when possible, to dispense with their use.

Hoop-iron Bond. Hoop-iron bond is sometimes introduced into walls to give a bond or tie in the direction of the length. But in walls built with cement mortar it is doubtful if it adds to the strength of the wall materially. It consists of strips of hoop iron about 1½ in. broad and $\frac{1}{20}$ in. thick, which, unless they are laid in cement mortar, should be tarred and sanded to protect them, and in order that the mortar may grip them. It is usual to insert the hoop iron in the mortar joints at certain definite intervals throughout the height of a wall varying from, say, four courses apart to 4 ft. or 5 ft. Each course in which they are used may have several strips of iron. If a joint has to be made in the length of the iron strip a lapped joint is used, and a similar joint is made at the angle of a wall, the two pieces being crossed and the end folded down [66]. Hoop iron bond is used in the construction of burglar-proof vaults, and for this purpose hoop iron is laid in every joint, and one strip is used for each half brick in the thickness of the wall, which is built of hard bricks in cement. It is claimed that a structure thus formed will resist even a determined attempt to penetrate it.

Bonding of Facings. It frequently happens, when the appearance of the exterior of a building is a matter of importance, that the bricks used for the face are required to be of a different quality and appearance from those used in the thickness of the wall, and in consequence may be more costly. In bonding such facings with the heart of the wall, if the bricks correspond in size with those used in the general body of the work, the bonding should be carried out exactly as already described for a wall of a uniform quality. The great danger to be feared is that, with a view to economy, half-bats may be employed where headers should be used; for as a true header can be broken into two bats, fewer of the more expensive bricks will be required when this is done; but if this plan is



EXAMPLES OF IRREGULAR BONDING

largely adopted the facing becomes a mere skin of brickwork a half brick in thickness, instead of being, as it should be, an integral part of the wall. It may sometimes happen that the size of the facing bricks differs from that of the bulk of the bricks. When this is the case really satisfactory bonding cannot occur, and such a condition must always be avoided if possible. For example, seven courses of facing bricks may be equal in height to six courses of the general work [**71**]. If this be so the joints will only correspond so as to form a true horizontal bed at every seventh course of the facings, and all that can be done is to introduce a course of headers at this point, and to build the courses up to the next level bed in stretcher bond.

Bonding Brick with Other Materials. The bonding described hitherto has referred to walls constructed wholly of brick. It frequently happens that for architectural effect or for some other reason part of the wall may be formed of other material, as, for example, terra-cotta or stonework. These materials may be introduced merely in the form of plinths, strings and cornices [**67**, **70**], at quoins [**69**], and round door and window openings—such work is described under the general term of *dressings*—or it may be used throughout the face of the wall [**68**]. In the latter case it may form merely a facing, the bulk of the wall being of brick, or the facing material may form the bulk of the wall, with merely an inner lining of brick to take the plastering. This last case, however, arises, as a rule, only when the material employed is of a rough character, such as that from which rubble walls or flint walls are formed. [See MASONRY.]

Brickwork and Terra-cotta. The bonding of brick with other materials may be a comparatively simple or a troublesome and costly process. Which it is to be will depend on the care given in preparing the material to be bonded with the bricks. The bricks are of a stock size, and if the work is to be easy in character this must be borne in mind, so that they can be utilised without cutting to any great extent. If terra-cotta be used, it must be specially manufactured for each building in which it is employed; if in moulding it care be taken to see that the height of each course with its mortar joint corresponds exactly with one or more brick courses with their mortar joints, and if the beds are also exact multiples in length and breadth of a half brick, the whole will bond together with ease. But if this be neglected, the terra-cotta, after it is burnt, must not be cut, and if the bricks have to be cut to fit it, this often involves much labour.

Brickwork and Stone. In the case of stone it is usual, except for rubble walls [see MASONRY] to dress the stone—*i.e.*, to reduce it to a fair face and to exact dimensions, and such stones can, therefore, usually be made of a size to bond with brickwork without any increase in the cost of working.

In the case of dressings, a string, of which the mouldings have only a slight projection, may be, for example, so designed as to correspond in height with two courses, and on bed to equal a half brick in width from front to back, with here and there a block of material equal to a whole brick [**67**]. In the case of quoins, whether plain or moulded, these may vary in height from one up to five or six courses [**69**], or even more, and they are usually arranged so that the widths of successive courses vary by the multiple of a quarter brick to assist in bonding. This is, however, not of such importance as the correspondence in height and width of bed, for it is an easy matter to cut the end off a brick to fit any quoin, even if irregular in form, but if the thickness or breadth of a course will not bond it may involve the reduction, by cutting, of a whole course of bricks.

Stone-faced Walls. Where a wall is to be faced with stone or terra-cotta the work is usually described as *ashlar* [see MASONRY], which implies that the stones or blocks are of regular height, length, and breadth, with a regularly dressed face. Such a facing may, of course, be made of any desired thickness, but, on the ground of expense, is often kept thin. The majority of the stones will be of the minimum thickness, but a certain proportion, equal to, say, one-third or one-fourth the area of the face of the wall, will be made thicker, so as to penetrate into the brick backing, and tie the backing and facing together; the difference between this thin and the thick courses should be half a brick or a multiple of half a brick.

In roughly-built stone walls, such as rubble walls, the bulk of the wall is of stone, and if brick is used it will generally be in the main a half-brick thick, with a certain proportion of headers built into the wall either in regular courses or as found convenient, but these should not be less than about one-fourth of the bricks.

Sometimes a flint-faced wall, if of knapped flints [see MASONRY], may be built as a facing to a brick wall, and in such a case the bond is usually secured by building in a proportion of extra long flints, so that they penetrate into the brickwork, but sometimes a small proportion of black, vitrified bricks may be used as headers, extending to the outer face of the flint to assist the bond.

Continued

ROAD MAKING

Asphalt, Brick, Cork-asphalt, Gutta-percha, Granite Sett, Macadam, Tar-macadam, and Wood Block Roads

continued from page 1983

By A. TAYLOR ALLEN

Asphalt. Although mineral rock asphalt was first discovered in 1712, it was not commercially adopted as a paving in Paris until 1854, when the first *comprimé* street—*i.e.*, on a concrete foundation—was laid down in the Rue Bergère, in the front of the Conservatoire de Musique, and in London until about ten years later, and it is only in comparatively recent years that its wider uses have been appreciated.

Mineral rock asphalt is a natural product, a pure limestone naturally impregnated with mineral bitumen. The rock when mined or quarried is of a chocolate colour, fine in grain, evenly impregnated with bitumen, which varies from about 6 to 20 per cent. It is usually found in seams or layers from 6 ft. to 30 ft. in thickness, like coal, and is mined in a similar manner. The principal supplies are taken from the Bassin de Seyssel, Haute Savoie, Switzerland; France; Limmer, in Hanover; and Ragusa, in Sicily. The weight of a cubic yard of natural asphalt is about 34½ cwt.

Use of Asphalt. During the last fifty years compressed mineral rock asphalt has stood the severe test of enormously increasing traffic in the principal streets of the City of London, the metropolitan districts, and the provincial cities and towns of the United Kingdom, and has proved to be the most satisfactory sanitary paving that can be laid. It is impervious to moisture, and non-absorbent, and, being jointless, nothing can get into crevices and decay. It has a smooth and even surface, is durable, economical, and quickly laid; and the preparation of compressed rock asphalt is similar to that of mastic asphalt for footpaths, except that the powder is placed in specially designed roasters with revolving cylinders and heated to a temperature of about 280° F. without any admixture whatever of bitumen.

As soon as the superfluous moisture has evaporated, the heated powder is placed in iron-sheathed vans, covered with thick cloths (to retain the heat), and taken to the site where it is to be laid. The asphalt powder is then laid on a Portland cement concrete foundation 6 in. to 9 in. thick, according to the nature of the traffic, well raked over the cement concrete foundation and rammed with hot rammers to the thickness required, then smoothed over with a hot smoothing iron so as to bring sufficient bitumen to the surface, after which a heavy roller is passed over it, while the asphalt is still warm, to straighten and consolidate the surface. When opened to the traffic the asphalt gradually begins to be compressed into solid rock again. In main traffic streets 2¼ in. of compressed asphalt are laid on about 9 in. of concrete. In streets of lighter traffic, the practice is 2 in. of compressed asphalt on 6 in. of concrete.

The Asphalt Road. An asphalt road can be constructed exceedingly flat, because a slight gradient is sufficient for rapidly removing the surface water; moreover, the vehicular traffic distributes itself without risk over the entire width of the road, even close up to the gutters, which is not the case, to the same extent, on a stone road. It suffices if, from the apex, which is simply rounded off slightly, two straight lines are drawn as cross or lateral gradients, an extra fall being given to the gutters for a width of about 18 in. As a rule, a lateral fall of 1 in 70 will suffice for the roadway, increased to 1 in 50 at the gutters. For the longitudinal fall 1 in 60 is considered the limit up to which the slipping of horses need not be feared.

The following well-known formula for calculating the camber of asphalt roads has been employed for many years:

$$f = c\,\frac{S^2}{S-7}$$

where f = camber (versed sine of arc),
s = width of roadway between kerbs,
c = coefficient (= 0·012).

Therefore, the normal camber of a roadway 30 ft. wide would be $0{\cdot}012\,\frac{30^2}{30-1} = 0{\cdot}372$ ft. in the centre.

Foundation for Asphalt. The concrete for the foundation should be gauged, six of aggregate to one of Portland cement. On no account must lime concrete be used. The thickness should be regulated according to the weight it has to bear. Cheapside, London, had in 1870, with a then traffic of 400,000 tons per annum per yard of width, a foundation of 9 in. in thickness, and after seven years it was reported to be in good condition. Gracechurch Street, in the same city, with 603,000 tons per yard of width per annum had also 9 in.; while other streets with less traffic had 6 in. Moorgate Street, with upwards of 6,000 vehicles per diem = 264,000 tons per annum per yard of width, had a foundation of 6 in.; all these latter streets maintained their surface in good condition. This would go to prove that under the heaviest traffic 9 in. is a sufficient depth, while 6 in. is sufficient for 250,000 tons per annum per yard of width.

It has also been ascertained from cutting into a piece of the already-mentioned roadway in Paris which had been subjected to heavy traffic for 16 years, that it had been reduced in thickness by only three-quarters of an inch.

Bricks for Paving. Bricks as a material for street paving have received very little

attention in England, although this country is justly celebrated for the quality of its bricks.

In Holland this class of paving has been in use for about 150 years, and in America about 13 or 14 years, where hundreds of miles have been laid in all sorts of ways and under varying conditions. Bricks obtained from Middlesbrough were laid in Liverpool as a trial in 1881, and a small piece of brick paving to form a carriageway was laid at Cheltenham in 1900. This paving was laid on a sand cushion with a foundation of 6 in. of cement concrete, the bricks being grouted in with pitch. The standard specification for the construction of brick carriageways adopted in the United States of America is as follows:

SUBSTRUCTURE, OR GRADING. Earth in excavation to be removed with plough and scraper or other device to within 2 in. of subgrade, then brought to true grade with the roller, the weight of which should be not less than 5 tons, or more than 8 tons. If the earth is too hard to receive compression through the weight of the roller, then loosen the remaining 2 in. with a pick and cart away. Earth in embankment must be applied in layers of 8 in. in thickness, and each layer thoroughly rolled; and in both excavation and embankment the subgrade must have a uniform density. If the ground is a spouty clay, tile drainage should be provided, to carry off the accumulation of wet.

CURBING. If cement is used, it should be completed; if stone, all should be hauled and distributed and set before the grading is finished, and it may then be used as a guide to finish the subgrade.

It should range in thickness from 4 in. to 6 in., and from 20 in. to 24 in. wide, the business and street traffic governing the same, and the lengths should not be shorter than 5 ft., except at closures. The top to be neatly dressed with a square or rounded outer edge, and 4 in. down on the inside. The outer surface to be tool-dressed to the depth of the face exposed, and to the depth of the thickness of the brick and sand cushion.

The intersection at street corners and alleys should be circular, with radius of 4 ft. and 3 ft. respectively.

MARGINAL CURB. These should always be of a hard and durable character of stone, and from 14 in. to 18 in. deep, dressed on top and 5 in. down on the face next to the brick, and should be set accurately, to fit the curvature of the cross section of the street on 6 in. concrete, and backed up with the same within 6 in. of the top.

CONCRETE FOUNDATION. Crushed stone should be of approved quality of hard rock, with no fragment larger than will pass through a 2 in. ring, and none smaller than will pass through a 1 in. ring in their longest dimensions, free from all refuse and foreign matter.

SAND. Sand must be clean, sharp, and dry, and thoroughly mixed in its dry state until the whole mass shows an even shade, with an approved brand of either hydraulic or Portland cement. If of hydraulic, the proportion of mixture should be one part of cement and two parts of sand. If of Portland cement, one part of cement and three parts of sand. To the above mixture should be added sufficient clean water to mix to a plastic mass, fluid enough to subside rapidly when attempting to heap to a cone shape. To this mixture add four and five parts respectively of damp crushed stone or clean screened gravel, and turn the whole mass over not less than three times, or until every fragment is thoroughly coated with the cement mixture. For the reception of this mixture the grade should be set off in 5 ft. squares, with a stake at each corner. Tops of each should be at the surface of concrete, which must be tamped until free mortar appears on the surface. Occasional sprinkling in extreme hot, dry weather is beneficial. After 36 hours the cushion sand may be spread.

SAND-CUSHION. Sand should be clean, and free from foreign or loamy matter. It need not necessarily be sharp. It should be 2 in. thick before the compression of the brick by rolling. The sand should be spread by the aid of a template the whole or one-half the width of the street, and made to conform with the true curvature of the street cross section.

BRICK. The brick should all be hauled and neatly piled inside the kerb line before grading is finished, or, if allowed by the engineer, delivered on the street in waggons and carried from the pile or waggon on pallets or with clamps, and not wheeled with barrows. They should be first class and thoroughly vitrified, showing at least one fairly straight face, with rounded edges, with no greater radius than $\frac{3}{16}$ in. They should not be less than $2\frac{1}{4}$ in. by 4 in. by 8 in., or more than $3\frac{1}{2}$ in. by 4 in. by 9 in., free from cracks, with but slight lamination, and at least one edge with but slight kiln marks allowed. Such bricks or blocks shall be submitted to a test of one hour in the National Brick Manufacturers' Association standard rattler and under the conditions prescribed by that association; and if the loss by abrasion during such test exceeds 20 per cent. of the original weight of the brick tested, then bricks or blocks shall be rejected.

BRICKLAYING. Bricks should be laid perpendicular to the kerb. Broken brick or block can only be used to break joint in starting courses or in making closures. The bricks shall be laid on edge, close together, in straight lines across the roadway between gutters. Gutters shall be constructed as directed by the engineer. After the bricks are laid they shall be thoroughly inspected, and all warped, spalled, and soft bricks removed and replaced by more perfect ones, and those found with the bad face up should be turned down.

TAMPING and ROLLING. After the inspection is thus completed the edge of the pavement shall be tamped to grade next to the kerb, to the width of 6 in. or 8 in. out from the kerb, with a hand tamper. The entire pavement shall then be rolled with a 5-ton steam roller until all bricks are thoroughly bedded, and the whole surface assumes a practical plane.

EXPANSION CUSHION. An expansion cushion must be provided for of 1 in. thickness next to the kerb, filled to two-thirds of its depth with pitch, the top one-third being filled with sand; and a like cushion at right angles with the street at intervals of 50 ft.

THE FILLER. The filler shall be composed of one part each of clean, sharp sand and Portland cement. The sand should be dry. The mixture, not exceeding one-third bushel of the sand, together with a like amount of cement, shall be placed in the box and mixed dry until the mass assumes an even and unbroken shade. Then water shall be added, forming a liquid mixture of the consistency of thin cream. From the time the water is applied until the last drop is removed and floated into the joints of the brick pavement, the same must be kept in constant motion. The mixture shall be removed from the box to the street surface with a scoop shovel, all the while being stirred in the box while it is being emptied. The box for this purpose shall be 3 ft. 6 in. to 4 ft. long, 27 in. to 30 in. wide, and 14 in. deep, resting on legs of different lengths, so that the mixture will readily float to the lower corner of the box, which should be from 8 in. to 10 in. above the pavement. This mixture, from the moment it touches the brick, shall be thoroughly swept into all the joints. Two such boxes shall be provided, in case the street is 20 ft. or less in width; exceeding 20 ft. in width, three boxes should be used. The work of filling should be thus carried forward in line until an advance of from 15 yd. to 20 yd. has been made, when the same force and appliances shall be turned back, and cover the same space again in like manner, except that the mixture for the second coating may be slightly thicker than the first. To avoid a possibility of the grout thickening at any point, there should be a man with a large sprinkling can, having the head perforated

with small holes, sprinkling gently the surface ahead of the sweepers. This should be done in the application of each course specified. After the joints are thus filled flush with the top of the bricks, and sufficient time for evaporation has taken place, so that the coating of sand will not absorb any of the mixture, one half of sand shall be spread over the whole surface, and, in case the work is subjected to a hot summer sun, an occasional sprinkling, sufficient to dampen the sand, should be followed for two days or three days. The grouting thus finished must remain absolutely free from disturbance or traffic of any kind for a period of ten days.

Cork Asphalt. Cork asphalt is a compound consisting of bitumen and certain other materials, including cork. It has been used in different parts of the world for a number of years, and possesses all the necessary features which constitute a good paving material. It is durable and elastic, and being non-absorbent to moisture, is therefore hygienic and sanitary. It is comparatively noiseless, and also non-slippery ; and, therefore, it is unnecessary in wet weather to sprinkle the surface with sand or fine gravel as is requisite with other pavements. The result of this is that there is a marked absence of mud, and, in dry weather, of dust. These properties make it invaluable for public roadways, especially as freedom from noise, dust and such discomforts is an object. It is claimed that no other pavement possesses such valuable characteristics, and cork asphalt is thus pre-eminently suitable for all classes of traffic, horse, motor, or otherwise. It is manufactured in the form of homogeneous blocks of uniform size, and the surface, when laid, is regular and even. Frost does not so readily act on it as on other classes of pavement.

The first cost of cork asphalt compares favourably with that of other pavements, and the cost of upkeep is much less, owing to its durable nature.

This class of road pavement has been largely used by H.M. Office of Works, at Buckingham Palace and Windsor Castle. The Paddington Vestry and the St. George's (Hanover Square) Vestry have applied cork asphalt with great success, and it has also been used by numerous provincial boroughs and corporations, such as Bournemouth, Eastbourne, and Newmarket.

Cork Asphalt in Railway Stations. Most of the principal railway companies have employed cork asphalt with satisfactory results, and among them may be mentioned the Great Eastern, the Great Northern, the North Eastern, the London and South Western, the Caledonian, and the North British railway companies. It is in use at Liverpool Street, King's Cross, Waverley (Edinburgh), and other stations.

This pavement is manufactured in blocks similar to wood blocks in sizes from 9 in. by 4½ in. by 1 in. thick to 9 in. by 4½ in. by 2 in. thick. It is laid on a concrete foundation, its cost compares favourably with that of wood, and its average life is longer.

Gutta-percha Paving. Gutta-percha, like cork, is the ideal of noiselessness, but is in a very experimental stage as yet, and has hardly come within the scope of practical consideration. A small piece is laid at the entrance to Euston Station, London, and in small, short sections at Glasgow. The sheets are laid down at their sides upon a concrete foundation by strips of iron, which clasp the edges tight on each other. Indiarubber in large sheets about 1 in. in thickness has been introduced in Hanover as a material with which to pave roads.

Granite Setts. A street pavement composed of this material has been in use for many years. This system was introduced into the country by the Romans. The size of the paving stones was, however, much larger than modern science finds necessary. One of the first granite pavements laid was that known as the "Euston pavement." This class of pavement consists of squared setts (the most general size being 6¼ in. by 3¼ in. by 5 in. to 7 in. long), laid on a concrete foundation consisting of cement concrete, the only reliable material. It should never be laid less than 6 in., while 9 in. will carry the heaviest traffic. The concrete should be composed as follows :

Six parts of screened ballast or gravel—all of which will pass through a screen of 2½ in. mesh—and one part of Portland cement, all thoroughly mixed upon a platform and used while in a semi-liquid state. The resultant mixture of one ton of cement when mixed in the proportion of six to one is about seven cubic yards of concrete. This will cover an area of 42 super. yd. 6 in. deep, and will take four labourers one day for mixing and laying.

Laying Granite Setts. As the concrete is laid in the trench the top surface should be brought to the proper camber with the shovel. For ordinary traffic, Aberdeen or Norway granites are largely used ; these are bedded on a sand packing free from small stones or pebbles, and average 1 in. in thickness, and laid touching one another, each stone being so firmly bedded on the packing that it has not to rely on the next one for support, and the setts laid to break joint. The ramming requires careful supervision, as, in order to avoid the trouble of lifting badly-laid setts, the men often try to get an even surface by ramming the high stones extra hard, and omitting to ram the low-lying stones, or stones inclined to give too much.

Local Practice. In the North of England and other places the joints are first filled with clean pebbles, after which the surface is well rammed, and then run with an asphaltic mixture, and covered with a layer of fine gravel, while in the South of England, the finished surface is usually grouted over with a liquid prepared from sand and lias lime, or Portland cement, and well washed into the joints. No traffic should be permitted on a newly-laid pavement of this class for 14 days. One ton of setts of the size mentioned will cover 3·6 superficial yards, and a pavior will lay an average of 30 superficial yards per day of 10 hours.

Macadam. The word "Macadam" is derived from Mr. John Loudon Macadam, the originator of macadam roads [1]. For this class of road, the ground is excavated in the usual manner to an approximate circular segment, and the foundation formed of "hard core," a term applied to a heterogeneous mixture consisting of chalk, broken stone, bricks, dry rubble, clinkers, and other dry and hard materials.

The thickness of the hard core depends on the nature of the subsoil, but 6 in. may be regarded as the minimum thickness, and this should be consolidated by rolling, all hollow places being filled in and made level. Upon this, a thin layer of dug flints or gravel should be uniformly spread and consolidated.

Then, to receive and withstand the wear and tear of the traffic, a 6 in. coating of stones or granite, broken to pass all ways through a ring of 2½ in. internal diameter, should be laid down, and well consolidated by watering and rolling, a little binding material being lightly scattered and swept in over the surface on completion.

Material for Macadamising. It is almost impossible to lay down any hard and fast line as to the material to be used over the whole kingdom for this description of road, as nearly every English county produces descriptions of stones, all suitable in a greater or less degree as a road-making material; but where the material is soft, it will be found economical to obtain a harder stone or granite from a distance, as the hardest description of stone should always be prepared. Those now commonly in use are basalt, Aberdeen, Guernsey, and other granites, Mountsorrel and Hartshill and Leicestershire stone. Picked slag, hill-picked surface and land-dug flints, and gravel, are also largely used for suburban side streets and rural roads where the traffic is not heavy. The relative cost of granite as a road metal and flints or gravel is roughly as 1 to 3.

Cherbourg Quartzite in England. Until 1885, this material was little known in England. At that date, the first cargo was imported and laid upon a length of road situated close to Gravesend, and remained eight years without needing repairs.

The natural cautiousness of the English engineer when dealing with something which has not been proved, has prevented this material from being classed with other granite as a road material

Rules for Laying Macadam. A rule to find the area of surface that can be covered by 1 cubic yard of broken material is as follows:

When the metal is not rolled divide 36 by the thickness of the proposed coating in inches; the quotient is the number of superficial yards that can be covered. When the metal is rolled divide 27 by the thickness in inches to give the required quotient.

A commonly adopted rule for ascertaining the camber of a macadam road is as follows:

Width of road, say, 30 ft.
At 4 ft. from centre (on each side), fall ½ in.
" 9 " " " " " " 2 in.
" 15 " " " (its extreme edge), 6 in.

1. TRANSVERSE SECTION OF MACADAM CARRIAGEWAY

This class of road is repaired by the old worn surface being picked up by manual labour, or by means of a scarifier, the new metal being put on and then steam-rolled with a small addition of matrix.

Tar. While it is only within comparatively recent years that tar macadam has been applied to road-making purposes, it has been used in Nottingham for upwards of 40 years, where the first piece of tar macadam was laid in this country. A few years ago, some Belgian engineers were sent over by his Majesty the King of the Belgians to make inquiries regarding the construction of tar macadam roads. The result of their visit was the making of a tar macadam road from Ostend to Blankenberghe, a distance of about 10 miles.

There is nothing new in the principle of mixing tar with road metal; but a material manufactured from the best hand-picked selected iron slag, and mixed by machinery specially designed, has been introduced to comply with the largely expressed desire for a tar macadam suitable for roadways, and is specially intended to meet the greatly increasing motor and other similar traffic which is now proving so damaging to the ordinary macadam road, principally due to the suction set up by the rubber tyres, which result in the disintegration of the finer material.

Cost of Tar Macadam. With roads made of tar macadam, the initial cost is not very much in excess of that for ordinary macadam, while the life is considerably greater, thus largely reducing —by 40 to 60 per cent.—the cost of repairs, and the expenses of scavenging.

The material is non-slipping, and has been laid on slopes and cambers of as much as 1 in 30 without any more effect than on an ordinary macadam road.

Preparation of Roadway. The surface of the roadway or other area proposed to be paved should (in the case of an existing road or old foundation) be scarified by a steam scarifier, or picked over by hand labour and levelled, to leave a camber, or fall, of the cross section of ½ in. to ⅝ in. to 1 ft., care being taken to excavate all soft and weak places, which should be taken out at least 1 ft. in depth, and filled in with good dry hard core. The whole surface should then be moderately steam-rolled to ensure thorough consolidation (which is a very essential point), but the rolling should be discontinued before the surface becomes "smooth," as a "key" is necessary, and an air circulation is required in the foundation.

Laying the Tar Macadam. The tar slag-macadam is then laid on the foundation prepared as above in two

coats of varying thickness, according to the traffic or purposes for which it is required, each coat being well rolled with steam-roller, weighing not more than 6 tons, and the surface on completion being dusted over with fine chippings, and finally well rolled until it is quite hard. The material of the *bottom* coat should be spread with shovels in the same way as ordinary macadam, and should be allowed to lie open before being rolled, for at least 24 hours, to allow it to become partially set and *tough*, which ensures the levels remaining true ; and the *top* coat laid with rakes (kept heated) to enable a level and true surface to be obtained. This coat should also remain open a few hours before rolling, and, where possible, the rolling of the material should not be done during rain or until it has had sufficient time to dry.

The thickness at which the material should be laid may be taken generally as shown below.

Roadways with local or through traffic. Work to be laid in two coats, totalling 4½ in. in thickness.

Bottom coat, 3½ in. thick of 2-in. gauge material.

Top coat, 1 in. thick of ¾-in. gauge material.

Roadways with light traffic. Work to be laid in two coats, totalling 3½ in. in thickness.

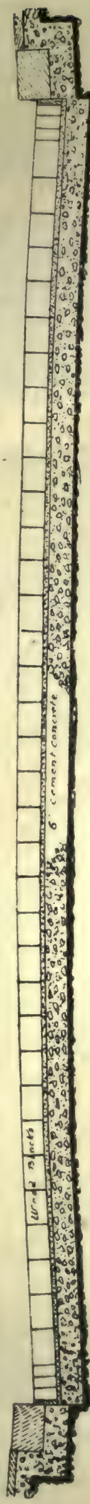
Bottom coat, 2¾ in. thick of 2-in. gauge material.

Top coat, ¾ in. thick of ⅝-in. gauge material.

The life of this description of paving may be taken as seven and five years respectively.

Wood Paving. The first wood-paved roadway laid in London was in front of Old Bailey in 1839. Since this date wood has made giant strides as a street paving. "It is admitted by all that it is of little use to lay any pavement without a good and substantial foundation, and none of the substances used requires this more than wood. Such being the case, a substantial concrete foundation is first laid, and it should cost the same, whether granite, wood, or other material be placed upon it ; consequently, the only thing to be considered is the cost of the wearing surface, the lasting qualities of same, and its desirability as a pavement when completed." A section of a wood-paved carriage-way is shown in 2.

Woods for Paving. A wood pavement as now laid consists of a good hard foundation of Portland cement concrete laid 6 in. thick and floated over to an even surface, conforming with the contour line of the proposed finished road. When sufficiently set, rectangular blocks of Jarrah, Karri, or others of the eucalyptus or blue gum types, 9 by 6 by 3 in., on



2. TRANSVERSE SECTION OF WOOD-PAVED CARRIAGEWAY

the face, cut die square, with the fibre vertical, are laid with close joints upon the finished surface of the concrete. To allow for the expansion of the wood transversely across the street, a 1½-in. expansion joint of sand is provided next to the kerb.

Filling the Interstices. The interstices between the blocks are sometimes grouted with liquid Portland cement and fine sand, a bituminous mixture of tar and pitch, or tar alone. The mixture is poured over the surface and "squeegeed" or brushed until it disappears between the wood blocks. The surface is then sprinkled with coarse sand or fine grit, and the traffic allowed to squeeze it, thus preserving its life and rendering the wood less slippery.

Creosoting the Blocks. If soft woods are used, the blocks should be creosoted by at least 10 lb. of creosoted oil being driven into every cubic foot of wood, so that each block may be thoroughly penetrated. The life of the blocks is not materially increased by the creosoting, but they are rendered less absorbent.

The life of this pavement depends upon the amount of traffic, quality of the material used, the locality (whether open or confined), and the width of the street, but the average estimated wear of Jarrah or Karri wood blocks may be taken at the rate of ⅜ in. per annum.

Karri wood is hard, heavy, and tough, and it is recognised as one of the most durable woods for street paving. It is cut from a tree whose average height is 200 ft. by 4 ft. in diameter at 3 ft. to 4 ft. from the ground, and has its first branches at a height of 120 ft. to 150 ft. The concrete foundation is similar to that already described under Granite Setts.

Future of Wood Paving. Like every other system of paving, wood has its advocates and opponents, its advantages and its disadvantages. One thing, however, is certain—it has come to stay, for whatever its opponents may say against it, it possesses the advantages the general public demands, and the public, who pays the piper, has a right to call the tune.

Soft woods have been used mostly in London on account of their being less noisy under traffic than hard woods, but their chief objection is that they wear more quickly than hard woods.

The comparative expansion of creosoted against plain soft wood blocks, after immersion in water for 48 hours has been found to be as follows :

On length of block	creosoted	·099	plain	·6
„ width	„	·57	„	·83
„ depth	„	·15	„	·31

These represent in a thirty feet carriageway, 2½ inch for plain blocks and practically ⅝ inch for creosoted blocks, if under the same conditions.

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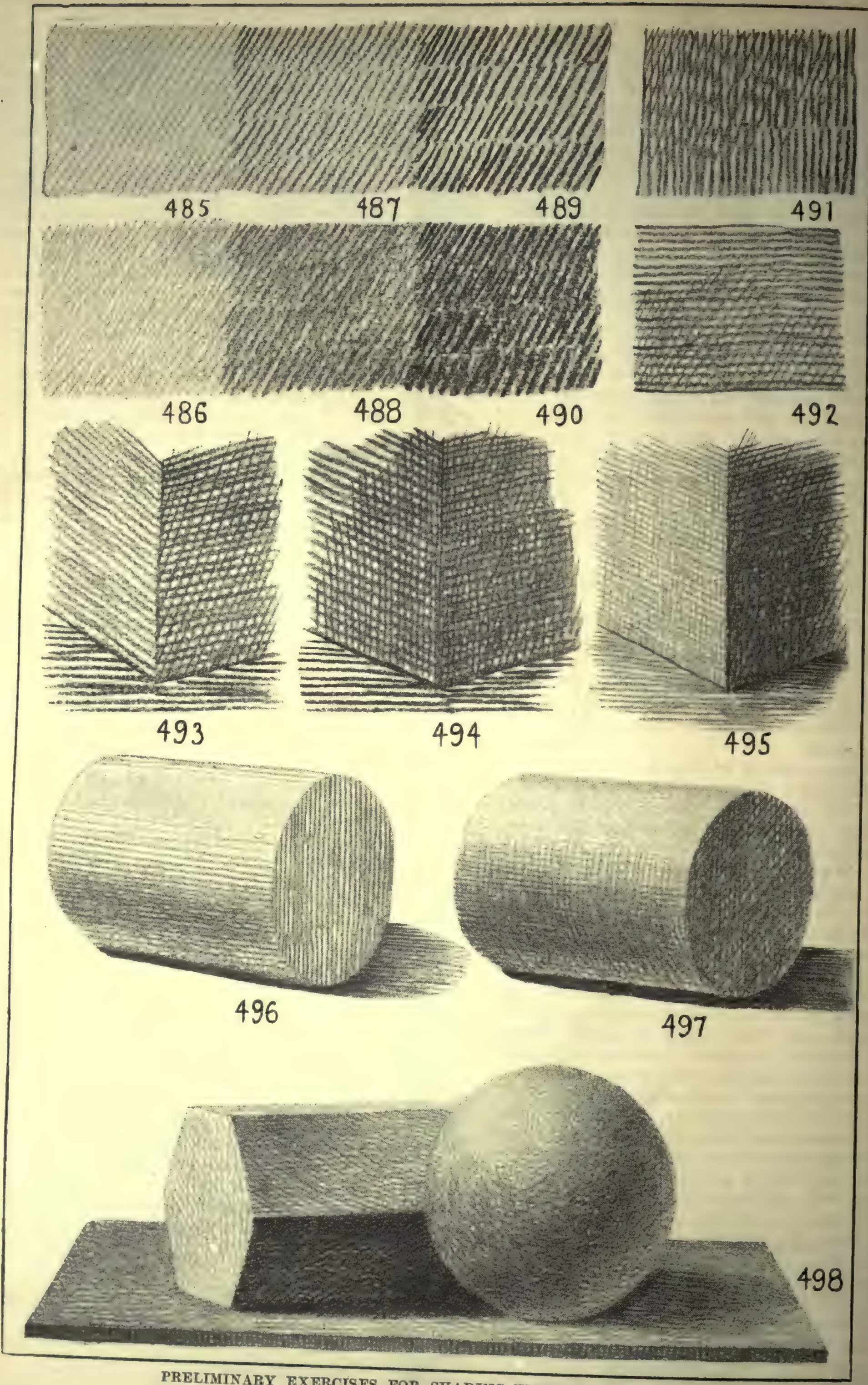


PRELIMINARY EXERCISES FOR SHADING WITH LEAD PENCIL

LIGHT AND SHADE

Drawing with Lead Pencil. Value of Line. Treatment of Surfaces. Suggestion of Light and Shade with Pencil, Crayon, Charcoal, etc.

Continued from page 2010

By WILLIAM R. COPE

Lead Pencil. It seems a great pity that ordinary lead pencil is not used more often than it is as a medium for artistically representing light and shade, to say nothing of expression, action, etc.

The pencil is clean, easy to handle, gives excellent results with a comparatively small amount of labour, and permits of a very high degree of "finish" in the drawing done with it. The "shine" and the likelihood of lines being smeared and rendered greasy in appearance when rubbed with the indiarubber, are perhaps its only disadvantages. It is the handiest and most workable material at the artist's disposal, and the most complicated and subtle effects of light and shade may be accurately expressed with it. It is possible with this medium to treat delicate gradation of tone as successfully as strong contrasts of deep and light tones, and to represent dainty modelling as easily as rugged forms.

The work, too, need not necessarily be laboured and weak, but breadth and largeness of massing of different tone areas may be secured with such an implement, because, by making broad strokes of the pencil that quality which water - colour washes give may be expressed with it. There is also the possibility of very minute detail with the point. Besides the ordinary HB, B, or BB pencils there is no objection to the use of a carpenter's pencil in order to obtain certain broad effects. Almost any paper which is not too rough is suitable for the drawing.

Method of Shading with Lead Pencil. By intelligently placed strokes of the pencil, the *direction* of surface, whether curved, vertical, horizontal, or receding, as well as the light and shade of different tone values, may be represented, which will conduce to careful study of form ; for, if the latter be not observed, the direction of stroke cannot be given properly.

Figures **485**, **487** and **489** show how the groundwork should be done for three different keys of tone, while **486**, **488**, and **490** indicate how each may be more highly finished to obtain a closer and more even tone. The length of each stroke should be that which can be comfortably and evenly executed with each movement of the

499. PENCIL DRAWING SUGGESTING LIGHT AND SHADE

500. STUDY IN LEAD PENCIL OF A PEONY

have its groundwork as in **493**, which is carried a stage further in **494**, but is rather coarse. A more delicate rendering is given in **495**. In both **494** and **495** some of the lines cross one another nearly at right angles; this is not always pleasing, and a more artistic appearance is shown in the sloping surfaces of the hexagonal prism in **498**.

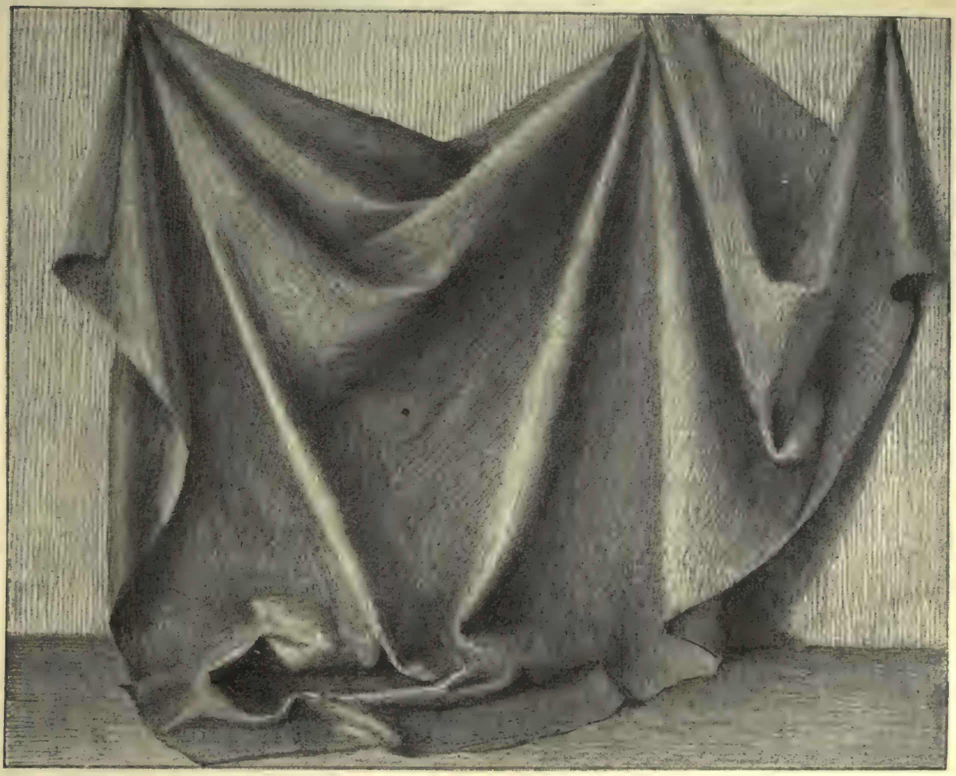
Straight and Curved Lines. The student must simplify his lines as much as possible when he wishes to render a tone quickly and in as direct a way as possible, as in **496**, where there is no cross-hatching whatever, and yet there is a good appearance of roundness and relief. Fig. **497** is more highly finished, but some artists would prefer the drawing in **496** to that in **497**. It should be noticed that curved lines are used in **497** on the curved surface; these are drawn in the hand or fingers. When an even tone is required, care should be taken not to let the ends of each stroke overlap the one above or below it, or the tone will have an undulating appearance.

Direction of Stroke. The direction of the stroke should be suited to the direction of the surface as much as possible. Thus, **491** shows vertical lines for a vertical surface. The oblique cross-lines are intended to represent a change of tone sometimes required on such a vertical surface, although it might well be represented by thicker lines perhaps closer together, *all vertical*, with no cross-hatching, in the same manner as the lines for the curved surface of the cylinder in **496**. A horizontal surface should be represented by horizontal lines, as in **492** and several succeeding examples. A receding surface may

501. STUDY OF A CAST OF A MAPLE LEAF

direction of the curvature of the surface. In **498** we have representations of horizontal, vertical, oblique, and curved surfaces. The student should carefully note the direction, varying thickness, and closeness of the lines used. In the sphere there are no straight lines at all, but curved ones crossing one another in such a way that there is no ugly appearance of reticulation as in **494**, and the lines are drawn in a free and light manner

It is no good to rub the pencil about anyhow on the paper; but before each stroke is made there should be a definite idea in the student's mind of what he wishes to represent. This **498** and **499**. Thus, the work is more direct, and executed with less labour, although the tone values are practically true in relation to one another. Notice the vertical lines for the vertical background, and the varying directions of the lines for the numerous undulations of the surface of the leaf. It would have been quite possible to use fewer lines still, and yet obtain truth of tone. The student must use his discretion in this respect. He should study good examples by well-known artists, see how they have used the lines with intelligence, and have made each one do its proper duty; then he will be trained to use them in the correct way.



502. HIGHLY-FINISHED SHADING WITH LEAD PENCIL

accuracy can only be obtained by very careful and searching observation of the object.

Shading Suggestive of Form. Fig. **499** is an example of pencil shading to suggest form without absolute accuracy of the relative values of the individual tones, whereas, in **498**, the latter are supposed to be quite accurate in relative value. The method used in **499** is very suitable for rapid sketching. Observe, in this example, the direction in which the lines are drawn; they follow, more or less, the curvature of the different muscles.

Study of Maple Leaf. The study of a cast of a maple leaf in **501** has the pencil work done with little or no cross-hatching, and the lines are rather wider apart than those used in

Study of Drapery. The study shown in **502** is carried to a very high degree of finish, and was executed on smoother paper than that used in **485—501**, and **503**. At first a fairly even tone was put over each mass with a broad, soft pencil, but each even tone was of a varying degree of value. Then line work of a finer nature was worked on the top, the artist all the time carefully endeavouring to render accurately the modelling of the many folds. As will be seen in the reproduction, the material was moderately dark in colour, and somewhat soft, with a texture like cloth. The student must always endeavour to indicate the material to be represented, so that one knows whether it is cloth, silk, satin, flannel, leather, or other material. This will give

503. SHADING IN PURE LINE WITH LEAD PENCIL

him plenty of exercise in choice of line most suitable for the representation of the material being studied. Lines of totally different consistency and character should be used to express rough or smooth surfaces ; for example, it is obvious that one must use entirely different qualities of line to represent the smoothness of an egg-shell, the roughness of texture of the scaly surface of a pine-cone, the soft feathers of a bird, the hair of animals, delicate human features, flowers, and thin drapery.

Study of Outdoor Life. The drawing of an old house shown in **503** exemplifies how the lead pencil may be used for outdoor studies. Again, notice the direction of the lines and the different kinds used, and that in the very dark portions the lines are so very close together that they do not show individually, but appear like a dark wash of colour. The original drawing was done on Whatman's "not" paper.

Flower Study. The flower study in **500** shows the kind of line which may be obtained on ordinary cartridge paper with a moderately smooth surface.

Shading with Other Mediums. What has been said in this lesson about lead-pencil work may be applied, with little variation, to drawings executed in carbon pencil, Conté crayon, or charcoal. With the last medium it is sometimes advisable to rub down the groundwork carefully and judiciously with the finger or thumb, or a paper stump, and then use line work upon that.

Charcoal, being halfway between the flexible brush and the firm, hard point of the pencil or pen, is a great favourite with most artists. Its softness and the ease with which it may be altered make it a very good medium for rapid studies in line or tone, or a mixture of both, in order to seize the effect of light and shade. Charcoal is capable of both delicacy and force, and bears working up to any extent. A gentle rubbing of the finger gives half tones when required, and helps to give greater solidity and finish to the drawing. This appearance of solidity may be further strengthened by letting the lines of shading, say for the deep shadows of drapery, run into solid blacks in the deep interstices of the folds. The latter principle is applicable to drawings made with either charcoal, crayon, chalk, pencil, pen, or brush.

In drawings done with carbon, pencil, and Conté crayon, each stroke, even the thinnest, is apt to become too black, unless the medium is used with caution and with the lightest possible touch. Also the work cannot very easily be corrected, owing to the difficulty of rubbing out the lines. Nevertheless, in the hands of those artists who know exactly what they wish to record, the use of such mediums will produce excellent results.

Continued

Continued from page 2052

SPANISH

Continued from page 2043

By Mme. de Alberti

THE ARTICLES

The Spanish definite articles are: *el*, the, feminine *la*, neuter *lo*.

The indefinite articles are: singular, masculine *un*, a, an; feminine *una*; plural, masculine *unos*; feminine *unas*.

The definite articles are as follows:

MASCULINE.

Singular.	*Plural.*
El, the	*Los*, the
Del, of the	*De los*, of the
Al, to the	*A los*, to the

FEMININE.

La, the	*Las*, the
De la, of the	*De las*, of the
A la, to the	*A las*, to the

NEUTER.

Lo, the	There is no plural
De lo, of the	
A lo, to the	

Del and *al* were formerly written *de el, á el*; the contracted form has been adopted for the sake of euphony.

The masculine article *el* is used with nouns of the feminine gender beginning with *a* or *ha*, when the stress is on the first syllable, as: *el agua*, the water; *el alma*, the soul; *el águila*, the eagle; *el hacha*, the hatchet; *el hada*, the fairy. In these cases the masculine article is adopted only in the singular for the sake of euphony, and the feminine article must be used in the plural: *las aguas, las almas, las águilas, las hachas, las hadas.* Other nouns beginning with *a*, as: *alegria*, joy; *aguja*, needle; *alhaja*, jewel, in which the stress is not on the first syllable, take the feminine article.

The masculine article *el* is sometimes used before the infinitive of a verb expressing a substantive idea, as: *el leer me gusta mucho*, I am fond of reading, or, reading pleases me very much; *el cantar bien es muy dificil*, it is very difficult to sing well; or, good singing is very difficult.

The article is sometimes omitted after a verb followed by the words *casa*, house; *palacio*, palace; *paseo*, walk; *misa*, mass, and others, as: *salgo de casa*, I am going out of the house; *voy á palacio*, I am going to the palace. But if a particular house or palace is specified the article is retained, thus: *salgo de la casa de mi padre*, I am going out of my father's house: *voy al palacio del rey*, I am going to the king's palace.

The plural of the indefinite article *unos, unas*, may be translated as some, or sometimes may be omitted, as: *He visto unos niños bailando*, I saw some children dancing, or, I saw children dancing.

The abuse of the indefinite article is denounced by the Spanish Academy as a Gallicism. Thus: *Puede muy bien cualquiera llegar a ser un gran hombre, sin estar dotado de un talento ni de un ingenio superior, con tal que tengo valor, un juicio sano, y una cabeza bien organizada.* (Anyone may come to be a great man without possessing a superior genius or talent, so long as he has courage, a sound judgment, and a steady brain.) In Spanish all the indefinite articles in this passage are superfluous.

Vocabulary	Vocabulario
Metals	Metáles
Gold	El oro
Silver	La plata
Copper	El cobre
Fire	El fuego
The earth	La tierra
Water	El agua
The wind	El viento
The air	El aire
The breeze	La brisa
The rain	La lluvia
Night	La noche
Day	El dia
The morning	La mañana
Noon	El mediodia
An hour	Una hora
Half an hour	Una media hora
A quarter of an hour	Un cuarto de hora
A minute	Un minuto
A second	Un segundo
A week	Una semana
A month	Un mes
A year	Un año
A century	Un siglo
Eternity	La Eternidad
The beginning	El principio
The end	El fin.
The bread	El pan
The wine	El vino
The meat	La carne
A fowl	Un pollo
A turkey	Un pavo
Coffee	Café
Chocolate	Chocolate
Tea	Té
A plate	Un plato
A dish	Una fuente
A cup	Una taza
A saucer	Un platillo

Roast meat	Carne asada
Boiled meat	Carne cocida
Veal	Ternera
Beef	Buey
Beefsteak	Biftek
Cutlets	Costillas
Veal chops	Chuletas
Soup	Sopa
A garden	Un jardin
An orchard	Un huerto
Flowers	Flores
Roses	Rosas
Violets	Violetas
Sunflower	Girasol
Dahlia	Dalia
Field flowers	Flores del campo
Poppy	Amapola
Poppy-head	Adormidera
Fruit	Fruta
Pears	Peras
Apples	Manzanas
Grapes	Uvas
Figs	Higos
Cherries	Cerezas
Plums	Ciruelas
Peaches	Melocotones
Apricots	Albericoques

The sea	El mar
The ocean	El océano
A river	Un rio
A lake	Un lago
A strait	Un estrecho
A pond	Un estanque
The bay	La bahia
A cove	Una ensenada
A port	Un puerto
The anchor	El ancla
The anchors	Las anclas
The king	El rey
The queen	La reina
The prince	El príncipe
The princess	La princesa
The princes	Los príncipes
The minister	El ministro
The Prime Minister	El primer ministro
The War Office	El ministerio de la guerra

The war	La guerra
The peace	La paz
The officers	Los oficiales
The soldiers	Los soldados
The arms	Las armas
A cannon	Un cañon
A gun	Un fusil
The bayonet	La bayoneta
A sword	Una espada
The gunpowder	La pólvora
The balls	Las balas
A cannon shot	Un cañonazo
A gun shot	Uu fusilazo
A pistol	Una pistola
A pistol shot	Un pistoletazo
White	Blanco
Rose pink	Rosa
Blue	Azúl
Sky blue	Azúl celeste
Red	Colorado
Crimson	Grana
Yellow	Amarillo
Green	Verde
Purple	Morado
Heliotrope	Heliotrope
Orange colour	Color de naranja
The prismatic colours	Los colores prismáticos
The royal colours	Los colores reales
To make one blush	Sacar los colores á la cara

Exercise II.

Translate the following into Spanish.

1. Gold and silver are considered [as] the most precious metals.
y son considerados como los más preciosos

2. The mines of copper are sometimes of more profit than those of gold and silver.
de á veces más provecho que las

3. Fire as [an] element is devastating.
devastador.

4. The air is fresh.
fresco.

5. The rain calms the wind.
aplaca

6. The night is for rest
para descansar.

7. The day is for work.
trabajar.

8. We fish in the river.
Pescamos

9. In the garden there are flowers.
hay

10. In the orchard there is fruit.
hay

11. The field flowers are artistic.
artisticas.

12. The North Sea is stormy.
mar del Norte tempestuoso.

13. The sea is placid.
placida.

14. The soul is immortal.
inmortal.

15. The souls of the just rest in the Lord.
justos descansan Señor.

16. The beneficent[2] fairy[1].
benéfica

17. The malevolent[2] fairies[1].
malévolas

18. To bury the hatchet is a sign of peace among the Indians.
Enterrar señal entre indios.

19. Hatchets[2] (were used[1]) as weapons of defence.
se usaban defensa

20. To drop the anchor.
Echar

21. The anchors of the ships.
navíos.

Note. In translating transpose the words as numbered.

Prose Extract II.

From "Lazarillo de Tormes," by Diego Hurtado de Mendoza.

How Lazaro took service with a priest, and of the things he endured with him.

———

The next day not thinking myself safe there I went to a place called Maqueda, where, for my sins, I fell in with a priest, of whom I asked alms. He asked me whether I knew how to serve mass. I said "Yes," which was true enough, for, though he ill-treated me, the blind sinner taught me many good things, and that was one of them. In the end the priest received me into his service.

———

I escaped the thunder and caught the lightning; for the blind man, though avarice itself, as I have related, was an Alexander the Great compared to this man. I will only say that all the stinginess on earth was incarnate in him. I do not know whether it was his own nature or if he had assumed it with his clerical habit. He had a large old chest secured with a key which he carried about fastened to the strap of his scapulary, and when the charity bread came from the church he would throw it in at once with his own hands, and lock the chest again. There was not a single eatable about the house, such as are usually seen in other houses: some bacon hanging in the chimney, a plate of cheese upon some shelf or in the cupboard, a (some) small basket with a few pieces of bread left over from the table; and it seemed to me that though they were no profit to me the sight of them would console me. There was nothing but a string of onions, under lock and key in a room at the top of the house.

———

Como Lázaro se asentó con un clérigo, y de las cosas que con él pasó.

———

Otro dia, no pareciéndome estar alli seguro, fuime á un lugar que llaman Maqueda, adonde me toparon mis pecados con un clérigo, que llegando á pedir limosna, me preguntó si sabia ayudar á misa. Yo dije que si como era verdad, que aunque maltratado mil cosas buenas me mostró el pecador del ciego, y unas de ellas fué esta. Finalmente, el clérigo me recibió por suyo.

———

Escapé del trueno y di en el relámpago; porque era el ciego para con este un Alejandro Magno, con ser la misma avaricia como he contado. No digo mas, sino que todo la laceria del mundo estaba encerrada en este, no sé si de su cosecha era, ó lo habia anejado con el habito de clerecia. Él tenia un arcaz viejo y cerrado con su llave, la cual traia atada con un agujeta del paletoque; y en viniendo el bodigo de la iglesia, por su mano era luego alli lanzado, y tornada á cerrar el arca. En toda la casa no habia ninguna cosa de comer, como suele estar en otras; algun tocino colgado al humero, algun queso puesto en alguna tabla, ó en el armario, algun canastillo con algunos pedazos de pan que de la mesa sobran, que me paresce a mi que aunque de ello no me aprovechára, con la vista dello me consolára. Solamente habia una horca de cebollas, y tras llave, en una cámara en lo alto de la casa.

———

My allowance of these was one every four days, and when I asked for the key to go and fetch it, if anyone were present he would put hand to pouch with great gravity, and untie the key and give it to me, saying, "Take it and return it directly, and do no more than feast your eyes," as though it unlocked all the preserves of Valencia, whereas there was not a cursed thing in the room (as I have said) except the string of onions hanging from a nail, and of these he kept so strict a count that if, for my sins, I had exceeded my allowance, it would have cost me dear.

———

At last I was nearly dead with hunger. But though he had small charity towards me he showed more to himself. Five half-maravedis worth of meat was his allowance for dinner and supper. It is true that he gave me a share of the broth, but clear as my eye of meat, and with only a little bread—I would to God he had gone halves with me.

———

It is the custom of that country to eat sheep's heads on Saturdays. He would send me for one costing three maravedis. Then he would cook it, and eat the eyes, tongue, brain, and meat off the skull and jaws, and give me all the gnawed bones on the dish, saying, "There, take it, eat. Triumph, you have everything on earth; you fare better than the Pope." "God send you the same," said I to myself.

———

Destas tenia yo de racion una para cada cuatro dias, y cuando le pedia la llave para ir por ella, si alguno estaba presente, echaba mano al balsopeto, y con grán continencia la desataba y me la daba diciendo, "toma y vuélvela luego y no hagais sino golosmear; como si debajo de ella estuvieran todas las conservas de Valencia, con no haber en la dicha cámara (como dije) maldita otra cosa que lás cebollas colgadas de un clavo, las cuales él tenia tambien por cuenta, que si por malos de mis pecados me desmandára á mas de mi tasa, me costara caro.

———

Finalmente, yo me finaba de hambre. Pues ya que conmigo tenia poca caridad, consigo usaba mas. Cinco blancas de carne era su ordinario para comer y cenar. Verdad es que partia conmigo del caldo, que de la carne tan blanco el ojo, sino un poco de pan, y pluguiera á Dios que me demediara.

———

Los sabados cómense en esta tierra cabezas de carnero, y enviábame por una que costaba tres maravedis; aquella la cocia y comia los ojos, y la lengua, y el cogote y sesos, y la carne que en las quijadas tenia, y dábame todos los huesos roedos, y dábamelos en el plato diciendo, "toma, come, triunfá, que para ti es el mundo; mejor vida tienes que el papa." "Tal te la dé Dios," decia yo paso entre me.

Diego Hurtado de Mendoza (1503-1575) was one of the most celebrated men of his age; a scholar, soldier, poet, statesman, and historian.	Diego Hurtado de Mendoza (1503-1575) fué uno de los hombres mas célebre de su tiempo, un literato, soldado, poeta, hombre político, é historiador.
"Lazarillo de Tormes," the autobiography of a beggar boy born on the banks of the Tormes, has been translated into nearly every European language. Short as it is, this book founded the school of the picaresque novel which Le Sage has made world renowned in "Gil Blas."	"Lazarillo de Tormes," la autobiografia de un muchacho mendigo, nacido en las orillas del Tormes ha sido traducido en casi todos los idiomas Europeos. Apesar de ser corto este libro ha fundado la escuela de la novela picaresca que Lesage en su Gil Blas ha hecho célebre en el mundo entero.

KEY TO EXERCISE I.

1. Las estrellas, los cometas, y la luna brillan en el firmamento.

2. Nada mas hermoso que el resplendor de la luna.

3. Pocos han visto la salida del sol.

4. La primavera es el tiempo mas agradable del año, el verano es demasiado caluroso. Los colores del otoño son pictorescos. El invierno no agrada á todos.

5. Un muchacho debe pasar por la niñez y la adolescencia antes de ser hombre.

6. La vejez es la precursora de la muerte.

7. Es una dicha que el porvenir nos sea desconocido.

8. El hombre no es mayor de edad hasta los veinte y un años.

9. La miseria es cruel.

10. El gasto de la educacion es grande.

Continued

ITALIAN

Continued from page 2046

By Francesco de Feo

NOUN SUBSTANTIVE

With the exception of a few names which end with a consonant (*gas*, *lapis*, etc.) all Italian nouns end with a vowel.

There are two genders in Italian—*masculine* and *feminine*.

The gender of the nouns may be known by their *signification* or by their *termination*.

1. By the signification:

(*a*) The names of metals, lakes, mountains (except *le Alpi*), months, and days of the week (except *la domenica*, Sunday) are masculine.

(*b*) The names of trees—except *la vite* (*veèteh*), the vine; *la querce* (*koo-èhrcheh*), the oak; *l'edera* (*éh-dehrah*), the ivy, are masculine.

Some names of trees have a corresponding feminine to indicate the fruit, as: *il noce* (*nò-cheh*), the walnut-tree; *la noce*, the walnut; *il pero* (*pèhro*), the pear-tree; *la pera*, the pear. Some names signify the fruit as well as the tree: *il limone* (*leemò-neh*), the lemon and the lemon-tree; *il fico* (*feèco*), the fig and the fig-tree.

Some fruits have a name quite different from that of the tree, as: *vite*, vine; *uva* (*oòvah*), grape; *palma*, palm-tree; *il dattero* (*dàhttehro*), the date.

2. By the termination:

(*a*) All nouns ending in *o* are masculine, except *mano* (*màhno*), hand, and *eco*(*èhco*), echo, in the singular.

(*b*) Nouns ending in *a*, *tà*, and *ù* (except *il Perù*) are feminine. Exceptions: *il patriarca*, *il monarca*, *il duca*, etc., and many names in *ma* and *ta*, of Greek origin, as: *il poeta*, *il clima*, *il poema*, *il pianeta*, etc.

(*c*) All nouns ending in *tore* are masculine, as: *il dottore* (*dottòreh*), doctor; *il genitore* (*dgeh-nee-tòreh*), father.

NOTE. *Calore* (*cah-lò-reh*) heat; *colore* (*colòreh*), colour; *dolore* (*dolòreh*), pain; *valore* (*vahlòreh*), value; *fiore* (*fee-ò-reh*), flower, which are feminine in French, are all masculine in Italian.

(*d*) All nouns ending in *ùdine*, *ziòne*, and many in *iòne* are feminine, as: *azione* (*ah-tsee-òneh*), action; *esposizione* (*ehsposee-tsee-òneh*) exhibition; *attitudine* (*ahttee-toò-deeneh*), attitude; *incudine* (*een-koò-deeneh*), anvil; *passione* (*pahssee-òneh*), passion; *confusione* (*confoo-see-òneh*), confusion.

(*e*) Nouns ending in *i*, which, however, are very few in Italian, are feminine, as: *la crisi* (*creè-see*), crisis; *la metròpoli* (*mehtròpolee*), the metropolis. Masculine are: *il brindisi*, *il Tamigi*, and some compound nouns ending also in *i*, as: *il portafogli* (*portah-fòlee-ee*), the pocket-book; *il portasigari* (*portah-seègah-ree*), the cigar-case.

Formation of Feminine Nouns.

1. (*a*) Proper names of persons ending in *o*, *e*, *i*; (*b*) common nouns, names of persons ending in *o*, and in *sore*; (*c*) and many in *e* form their feminine in *a*, as: *Alessandro, Alessandra*; *Claudio, Claudia*; *Giuseppe, Giuseppa*; *Luigi, Luigia*; *ragazzo, ragazza*, girl; *scolaro, scolara*; *uccisore, uccisora*; *padrone*, master, *padrona*, mistress, etc.

NOTE. The form *ditrice* for the feminine of some nouns in *sore*, as *difenditrice, ucciditrice*, etc., is now out of use.

2. Nouns in *tore* form their feminine in *trice*, as: *autore* (*ah-ootòreh*) author, *autrice* (*ah-ootreè-cheh*); *imperatore*, emperor, *imperatrice*; *pittore*, painter, *pittrice*, etc. Some nouns in *tore* have also a form in *tora*, as: *lavoratore* (*lah-vorahtòreh*), workman; feminine, *lavoratrice* and *lavoratora*. *Dottore* is used both for the masculine and the feminine.

NOTE. *Dottore* has also a form *dottoressa*, which is used in speaking of a woman who affects to be learned.

3. Some names in *a*, *e*, *o*, form their feminine in *èssa*, as: *poeta*, *poetessa*; *prìncipe* (*preèn-chee-peh*), *principessa*; *barone* (*bahròneh*), *baronessa*; *filòsofo* (*feelòsofo*), *filosofessa*. Note here that *guàrdia* (*guàhr-dee-ah*), guard; *guida* (*gueèdah*), guide; *sentinella* (*sehnteenèhllah*), sentinel; *spia* (*speè-ah*), spy, although generally referring to men, are always feminine. The same may be said of *vittima* (*veèttee-mah*), victim.

4. All nouns ending in *ista*, and many ending in *e* (especially *ente*) are of both genders, as: *il pianista, la pianista*; *il violinista, la violinista*; *il parente* (*pahrèhnteh*), relation, *la parente*; *il conoscente* (*conoshèhn-teh*), acquaintance, *la conoscente*, etc.

NOTE. *Il fine* (*feè-neh*) the aim, *la fine*, the end.

5. Of the names of animals, those ending in *e* form the feminine in *essa*: *leone* (*leh-òneh*) lion, *leonessa*; those ending in *o* form the feminine in *a*: as *gatto* (*gàhtto*) cat, *gatta*.

But many names of animals have one form masculine or feminine for both genders, and must be distinguished, as in English, by the words *maschio* (*màhs-keeo*), male; *fèmmina*, female, as: *la mosca*, the fly; *la tigre* (*teègreh*), the tiger.

6. Some names of persons and animals are quite irregular, and have, as is often the case in English, two different forms for the two genders. The most important are:

maschio (*màhs-keeo*), male
fèmmina (*fèhmmeenah*), female
uomo (*oo-òmo*), man
donna (*donnah*), woman
padre (*pàhdreh*), father
madre (*màhdreh*), mother
fratéllo (*frahtèhllo*), brother
sorella (*sorèllah*), sister
marito (*mahreèto*), husband
mòglie (*mòlee-eh*), wife
gènero (*dgèh-nehro*), son-in-law
nuora (*noo-òrah*), daughter-in-law
patrigno (*pahtreè-nee-o*), stepfather
matrigna (*mahtreè-nee-ah*), stepmother

re (*reh*), king	*regina* (*rehdgeè-nah*), queen
eroe (*ehrò-eh*), hero	*eroina* (*ehro-eènah*), heroine
dio (*deè-o*), god	*dea* (*dèh-ah*), goddess

gallo (*gàhllo*), cock	*gallina* (*gahlleè-nah*), hen
pollo, chicken	*pollostra* (*pollàhstrah*), pullet
cane (*càhneh*), dog	*cagna* (*càh-nee-ah*), bitch
montóne, ram	*pècora* (*pèhcorah*), ewe
porco, pig	*tròia* (*trò-ee-ah*), sow (besides the regular *pòrca*)

bue or *bove*, *toro*, ox; *vacca* (*vàhccah*), cow

EXERCISE VII.

ON THE GENDER OF NOUNS.

Il re e la regina sono a Windsor. L'imperatore e l'imperatrice della Russia andranno (will go) in Frància il mese d'agosto. La moglie della guàrdia è una donna lavoratora. Gli alpinisti e le guide si sono perduti (have lost themselves) nelle Alpi. Il bue, la vacca, la capra, la gallina sono animali utili (useful) all' uomo. La leonessa e la tigre sono più feroci del leone e della tigre maschio. La sorella di Luigi ha due fanciulli (two children), un maschio e una femmina. L'uva e il dattero sono i frutti della vite e della palma. Il fratéllo e la nipote della baronessa hanno intenzione di andare a Parigi. Una moltitudine di ragazzi e ragazze (boys and girls) sono in campagna (in the country) con la maestra e con la padrona di casa. Il gènero del dottore è un artista e la sorella è una pianista. La figlia del mèdico è dottore in lèttere e anche poetessa e pittrice, essa è autrice d'un poema e d'un quadro, che (which) è all'esposizione di Berlino.

INDICATIVE MOOD OF THE VERB

Avere (To Have).

Present.

Io ho, I have	*noi abbiamo*, we have
tu hai, thou hast	*voi avete*, you have
egli ha, he has	*essi hanno*, they have

Past Indefinite.

Io ho avuto, I have had
tu hai avuto, thou hast had
egli ha avuto, he has had
noi abbiamo avuto, we have had
voi avete avuto, you have had
essi hanno avuto, they have had

Imperfect.

Io avevo (*ahvèvoh*), I had	*noi avevamo*, we had
tu avevi, thou hadst	*voi avevate*, you had
egli aveva, he had	*essi avèvano*, they had

Pluperfect.

Io avevo avuto, I had had
tu avevi avuto, thou hadst had
egli aveva avuto, he had had
noi avevamo avuto, we had had
voi avevate avuto, you had had
essi avèvano avuto, they had had

Past Definite.

Io ebbi (*èh-bbee*), I had	*noi avemmo* (*ahvèhmmo*), we had
tu avesti, thou hadst	*voi aveste*, you had
egli ebbe, he had	

essi èbbero, they had

Second Pluperfect.

Io ebbi avuto, I had had
tu avesti avuto, thou hadst had
egli ebbe avuto, he had had
noi avemmo avuto, we had had
voi aveste avuto, you had had
essi èbbero avuto, they had had

Future.

Io avrò (*ahvrò*), I shall have
tu avrai, thou wilt have
egli avrà, he will have
noi avremo, we shall have
voi avrete, you will have
essi avranno, they will have

Second Future.

Io avrò avuto, I shall have had
tu avrai avuto, thou wilt have had
egli avrà avuto, he will have had
noi avremo avuto, we shall have had
voi avrete avuto, you will have had
essi avranno avuto, they will have had

Indicative Mood of the Verb

Èssere (To Be).

Present.

Io sono, I am — *noi siamo,* we are
tu sei, thou art — *voi siete,* you are
egli è, he is — *essi sono,* they are

Past Indefinite.

Io sono stato, stata (fem.), I have been
tu sei stato, -a, thou hast been
egli è stato, he has been
noi siamo stati, -e, we have been
voi siete stati, -e, you have been
essi sono stati, they have been

Imperfect.

Io ero, I was — *noi eravamo (ehrah-vàhmo),* we were
tu eri, thou wast — *voi eravate,* you were
egli era, he was — *essi èrano,* they were

Pluperfect.

Io ero stato, -a, I had been
tu eri stato, -a, thou hadst been
egli era stato, he had been
noi eravamo stati, -e, we had been
voi eravate stati, -e, you had been
essi èrano stati, they had been

Past Definite.

Io fui (foò-ee), I was — *noi fummo,* we were
tu fosti, thou wast — *voi foste,* you were
egli fu, he was — *essi fùrono,* they were

Second Pluperfect.

Io fui stato, -a, I had been
tu fosti stato, -a, thou hadst been
egli fu stato, he had been
noi fummo stati, -e, we had been
voi foste stati, -e, you had been
essi furono stati, they had been

Future.

Io sarò, I shall be — *noi saremo,* we shall be
tu sarai, thou wilt be — *voi sarete,* you will be
egli sarà, he will be — *essi saranno,* they will be

Second Future.

Io sarò stato, -a, I shall have been
tu sarai stato, -a, thou wilt have been
egli sarà stato, he will have been
noi saremo stati, -e, we shall have been
voi sarete stati, -e, you will have been
essi saranno stati, they will have been

Note. The compound tenses of the verb *èssere* are formed with the same verb *essere* and *not* with *avere* : *Io sarò stato* (literally, I shall be been), I shall have been.

Exercise VIII.

The verbs *èssere* and *avere,* conjugated in the *interrogative, negative,* and *interrogative-negative* forms.

Egli ha. Egli non ha. Ha egli ? Non ha egli ? Essi avevano. Essi non avevano. Non avevano essi ? Non hanno essi avuto ? No, ma essi avranno. Quando (when) avranno ? Quando saranno stati. Non sono essi stati ? Essi furono, ma noi eravamo già (already, pron. dgee-àh) stati. Non avrete avuto ? Non sarete stati ? Non avremo noi ? Voi avrete quando sarete, essi avranno quando saranno stati. Hanno avuto ? Non avranno ? Aveste ? Avevate ? Furono ? Sono ? Non sono, ma saranno quando avranno avuto.

Key to Exercise IV.

1. The friend. I have a friend. Thou hast a rose. He has a daughter. We have a house. The boy has a pen. The sculptor has a statue. The uncle has a brush. The pupil has a book and a pen. You have a sister. They have a horse and a carriage.

2. The boys have a knife and a pen-knife. You have the envelopes and the pens. The pupils have the envelopes and the books. The sculptors have the statues. The uncles have the houses. The boy has the roses. The friends have the birds, the horses, and the carriages.

Key to Exercise V.

A hat of silk (silk hat). The statue of the sculptor. The physician of the house. The envelope of the letter. We have received a letter from Paris. From London to Paris, and from Paris to Rome. The books of the pupils are on the table. The gentleman and the lady are in the garden of the sculptor. The boys have received a present. The daughter of the physician has received a ring of gold (gold ring) The friends have bought a house with the money received from Rome. The letters for the lady are on the table in the room of the boys.

Key to Exercise VI.

Some horses for the carriages. Some roses in the garden. The ladies have some roses. We have received some presents. The boy had some books. He bought some envelopes and pens for some pupils. Have they many horses ? The ladies have received some letters from Paris. The sculptor had horses, carriages, houses, and gardens.

Continued

FRENCH

Continued from page 2049

By Louis A. Barbé, B.A.

DEMONSTRATIVE PRONOUNS

1. The Demonstrative pronouns (*pronoms démonstratifs*) are :

ce, it, that ;
ceci, cela, this, that ;
celui (m.), *celle* (f.), that, the one ;
ceux (m.), *celles* (f.), those ;
celui-ci (m.), *celle-ci* (f.), this, this one, the latter ;
ceux-ci (m.), *celles-ci* (f.), these, the latter ;
celui-là (m.), *celle-là* (f.), that, that one, the former ;
ceux-là (m.), *celles-là* (f.), those ; the former.

2. *Ce* as a demonstrative pronoun is used either (*a*) before *être* (which may be preceded by a third person singular of *pouvoir* and *devoir*), or (*b*) as antecedent of the relative pronoun, the two together meaning "what," and *ce qui* being used as subject, whilst *ce que* is used as object :

c'est lui, it is he ;
ce peut être lui, it may be he ;
ce doit être lui, it must be he.

Ce qui est vrai n'est pas toujours agréable, what is true is not always pleasant ; *ce que vous m'avez dit est-il vrai ?* Is what you have told me true ?

3. *Ce* is used instead of *il, elle, ils, elles* before the verb *être*, when that verb is followed by a noun having an article, a demonstrative adjective, or a possessive adjective before it :

Qui est ce monsieur ? C'est le père de mon ami, Who is that gentleman ? He is my friend's father ;

Qui est cette demoiselle ? C'est ma sœur, Who is that young lady ? She is my sister ;

Qui sont ces messieurs ? Ce sont des amis, Who are those gentlemen ? They are (some) friends.

4. When the noun which follows *être* is not accompanied by an article, etc., it has the value of an adjective, and the verb is then preceded by *il, elle, ils, elles :*

Il est soldat, he is a soldier ;

Elles sont institutrices, they are governesses.

5. When a third person singular of "to be" is preceded by "it," and followed by an adjective, the "it" is rendered by *il* if the adjective applies to a statement that is going to be made, and by *ce* if it applies to a statement that has just been made :

Je ne le connais pas, c'est vrai, I do not know him, it (that) is true ;

Il est vrai que je ne le connais pas, it is true that I do not know him.

6. *Ceci*, this, and *cela*, that (contracted into *ça* in ordinary conversation) do not refer to any noun mentioned before ; they can only be used in connection with objects, and not persons ; and they have no plural ; *Ceci* refers to the nearer object pointed out, and *cela* to the more remote :

Je n'aime pas ceci, donnez-moi cela, I do not like this, give me that.

7. *Ceci*, like "this," in English may refer to a statement that is going to be made ; and *cela*, like "that," to a statement that has just been made :

Retenez bien ceci : Le pain que nous gagnons est le meilleur, bear this well in mind (lit., retain this well) : the bread we earn is the best.

La pratique rend maître, n'oubliez pas cela, practice makes perfect, do not forget that.

8. *Celui, celle, ceux, celles*, without either *ci* or *là* added to them, are used only in two constructions : 1st, before a relative pronoun ; 2nd, before the proposition *de*. The latter construction renders the English possessive :

J'aime mieux votre livre que celui que j'ai, I like your book better than the one I have ;

Je l'aime mieux que celui de votre frère, I like it better than your brother's.

POSSESSIVE PRONOUNS

1. Possessive pronouns (*pronoms possessifs*) of which the agreement, like that of the possessive adjectives, is with that which is possessed, and not with the possessor, are :

	Mas. Sing.	Fem. Sing.	
1st per. sing.	*le mien,*	*la mienne ;*	mine
2nd per. sing.	*le tien,*	*la tienne ;*	thine
3rd per. sing.	*le sien,*	*la sienne ;*	his, hers
1st per. plur.	*le nôtre,*	*la nôtre ;*	ours
2nd per. plur.	*le vôtre,*	*la vôtre ;*	yours
3rd per. plur.	*le leur,*	*la leur ;*	theirs

	Mas. Plur.	Fem. Plur.	
1st per. sing.	*les miens,*	*les miennes ;*	mine
2nd per. sing.	*les tiens,*	*les tiennes ;*	thine
3rd per. sing.	*les siens,*	*les siennes ;*	his, hers
1st per. plur.	*les nôtres,*	*les nôtres ;*	ours
2nd per. plur.	*les vôtres,*	*les vôtres ;*	yours
3rd per. plur.	*les leurs,*	*les leurs ;*	theirs

2. Possession is also expressed by means of the verb *être*, followed by the preposition *à* and a disjunctive personal pronoun :

Ce cheval est à lui, that horse belongs to him.

There is, however, a difference between *à moi*, etc., and *le mien*, etc. Ownership, and nothing else, is implied by *à moi*, etc., whilst *le mien*, etc., is used to distinguish the ownership of one object from that of others :

Cette bague est à moi, That ring belongs to me ;

Cette bague est la mienne, That ring is mine (the others are not).

3. The English expression "of mine," etc., is rendered, not by the possessive pronoun, but by the possessive adjective :

He is a friend of ours, *C'est un de nos amis.*

4. *À moi, à toi*, etc., are used with the other possessives, both adjectives and pronouns, to emphasise them :

Est-ce de ma faute, à moi, qu'il n'ait pas réussi ?

Is it *my* fault if he has not succeeded ?

5. *À moi, à toi*, etc., preceded by *ce* + *être* and followed by *à* or *de* with an infinitive, form two idiomatic expressions expressing respectively duty, province, privilege, etc., and turn :

C'est à vous à commander, c'est à lui à obéir.

It is your province to command, it is his duty to obey.

C'est à vous de jouer, it is your turn to play.

Exercise XVII.

1. This pen is good, but that is better.
2. She has shown (*montré*) me her hat and her sister's.
3. I like ours better than theirs.
4. If it is not he, it is his brother.
5. Who are those young ladies ? They are our cousins.
6. Is this gentleman a barrister (*avocat*) ? No ; he is a doctor (*médecin*).
7. He is one of our most distinguished (*distingué*) doctors.
8. I do not know that gentleman ; I have seen him once or twice, it is true, but I have never spoken to him.
9. It is true that we have never spoken to him, but we know (*connaissons*) him very well by sight (*de vue*).
10. Have you done that ? No, it was (is) not I, it was he.

11. If you have any finer engravings (*gravures*, f.), show them to me ; I do not like these.

12. What you have just read (*venez de lire*) is very interesting, but it is not true.

13. This room is smaller than ours ; it is the smallest in the whole house.

14. Give me another handkerchief, please (*s'il vous plaît*) ; I have lost mine.

15. Our flowers are beautiful, your sister's are still (*encore*) more beautiful, but yours are the most beautiful.

16. That ring is not mine, I have none ; it belongs to a friend (f.) of mine.

17. It is not *her* ring that she (*qu'elle*) has lost (*perdue*) ; it is mine.

18. Whose turn is it to play ? It is yours.

Key to Exercise XV.

1. Je cherche mon livre et mes plumes.
2. Vous avez parlé à mon frère et à ma sœur.
3. Il a donné un cadeau à son ami.
4. Il me cherche.
5. Elle vous parle.
6. Nous lui avons donné une montre.
7. Il ne leur parle pas.
8. Leur a-t-elle donné un cadeau ?
9. A-t-il trouvé sa montre ?
10. Je te donne cela, me dit-il.
11. Donnez-le-moi, nous dit mon père.
12. Achète-toi un parapluie.
13. Nous nous levons tous les jours à sept heures.
14. Ils ne se couchent jamais avant onze heures.
15. Nous le leur donnons.
16. Elle vous la prête.
17. Il nous en a donné.
18. Vous nous en avez parlé.
19. Si vous avez de l'argent, donnez-lui-en.
20. Ne lui en parlez pas.
21. Nous ne nous y opposons pas.
22. Si vous cherchez vos gants, les voici.
23. Vous vous trompez.
24. Ils se flattent.

Key to Exercise XVI.

1. Ils sont contre moi et pour eux.
2. Elle ne se fie pas à lui.
3. Qui avez-vous vu ? Lui.
4. Qui leur a répondu ? Eux.
5. Qui est là ? C'est moi.
6. Nous irons ensemble, toi et moi.
7. Il nous a parlé, à lui et à moi.
8. Nous y avons été plus souvent qu'eux.
9. Elle est plus intelligente que lui.
10. Eux, que nous croyions nos amis, nous ont trahis.
11. Il travaille, lui, mais toi, tu ne fais que jouer.
12. Lui dire une telle chose !
13. Eux ont fourni l'argent, lui a bâti la maison.
14. Si vous ne me croyez pas, moi, le croirez-vous, lui ?
15. Cet enfant a écrit la lettre lui-même.
16. Elles m'ont dit elles-mêmes qu'elles viendraient ce soir.
17. Ils ne sont jamais chez eux le soir.
18. Chacun pour soi et Dieu pour tous.

Note. The next lesson in German appears in the succeeding instalment of the Language section.

Continued

STRESS DIAGRAMS FOR BEAMS

Combined Diagrams. Rolling Loads. Continuous Beams. Compound Girders. Plate Girders. Columns and Stanchions

continued from page 1983

By Professor HENRY ADAMS

Combined Diagram for Irregular Loading. When a beam or girder is irregularly loaded with concentrated loads it is not necessary to work out the effect of each load separately, as in page 1987. Both the bending moments and the shearing stresses can be very neatly shown upon a single diagram, as in **140**. Upon a line indicating the girder draw force lines indicating the loads and reactions, then number the spaces into which the length is separated by the force lines, these numbers being shown in circles for distinction. Produce the lines downwards, and upon the right-hand line mark off the loads to scale. The first load of 2 tons is known as force 1–2, being named by the numbers of the spaces it separates, and is marked on the right-hand line by the distance from 1 to 2. Load 2–3 of 5 tons, and load 3–4 of 3 tons are set out similarly. Then a pole, O, is selected at a distance of, say, 10 ft. from the load-line, using the scale to which the girder was drawn. The pole is then joined to the points in the load-line by vectors. The bending-moment diagram is drawn parallel to these vectors, beginning with line 1 across space 1, started at any point on the left-hand line. Then, continuing it with line 2 across space 2, line 3 across space 3, and line 4 across space 4, joining the extremities of the bending-moment diagram by a line across space 5, a vector is then drawn parallel to it from the pole giving point 5 on the load-line, and consequently fixing the amount of each reaction, or load on support, 4–5 and 5–1.

Details of the Combined Diagram. The bending-moment diagram is called a funicular polygon (Latin *funis*, a cord), because if a cord or chain were fixed at the two extremities and the given weights hung on at the respective points under the load, the cord would take the shape given by the funicular polygon. If the girder has been drawn to a scale of $\frac{3}{16}$ in. to 1 ft., and the load-line to a scale of $\frac{1}{4}$ in. to 1 ton, the polar distance being 10 ft., the vertical ordinates on the bending-moment diagram will be to a scale of $\frac{1}{10}$ of $\frac{1}{4}$ in. to 1 ton-foot, or 40 ton-ft. to 1 in. The shearing stresses will be shown by drawing a horizontal line from point 5 on the load-line as a base, and then projecting from the other points as shown. The vertical ordinates of shearing stress will be to the same scale as the load-line—say, $\frac{1}{4}$ in. to 1 ton, or 4 tons to 1 inch. If the load of 5 tons had been spread over a distance of, say, 4 ft., a slight modification would show the alteration produced in the bending-moment diagram, as in **141**. Lines are drawn down from the ends of the load W, spread over the distance z, and their intersections with the lower outline of the diagram are found by a straight line upon which a parabola is constructed having a depth of $\frac{Wz}{8}$ to the scale of 40 ton-ft. to 1 in. The shearing stresses will also undergo modification as shown.

Rolling Loads. Girders for bridges, travelling cranes, etc., are subject to rolling loads. The simplest case is that of a concentrated load coming on to a girder from one end and travelling along it. In **142** is shown by full lines the bending-moment diagram for the load in its given position, and by dotted parabola the range that would be produced by taking the maxima throughout the travel. Similarly, **143** shows by full lines the shearing stresses with the load in its given position, and by dotted semi-parabolas with the vertices at each abutment the shearing stresses produced by taking the maxima throughout the travel.

Continuous Beams. When a beam is continuous over two or more equal spans the pressure upon the supports from a uniformly distributed load is not uniform. This is proved by what is called the "Theorem of Three Moments"; but it will be sufficient to give the results, as in the following table, for equal spans uniformly loaded, the load on each span being unity, and the supports perfectly level and rigid.

No. of Spans.	Abutments.	1st Pier from each end.	2nd Pier from each end.
2	·375	1·25	—
3	·4	1·1	—
4	·393	1·143	·93
5	·394	1·131	·989

When the number of spans exceeds five, the loads may be taken on the end supports as for five, and the remaining supports may be considered as carrying unity loads without much error. Putting it another way, if a beam continuous over two equal spans carry a uniformly distributed load, five-eighths of the total load will rest upon the central support and three-sixteenths upon each of the abutments; or, if continuous over three equal spans, $\frac{11}{30}$th of the load will rest upon each of the inner supports and $\frac{4}{30}$th upon each of the abutments. Testing the theory by means of a lattice girder and reciprocal diagrams, it is found that when the distribution of loading is altered by raising or lowering the supports the minimum stresses exist in the girder with the above distribution.

Beam with Fixed Ends. When the ends of a beam are sufficiently fixed it is equivalent to one span of a continuous beam, as in **144** under a

concentrated load, and **145** under a distributed load. The end spans are usually merely supported on the abutment, but continuous towards the next span; they are, therefore, in the condition of **146** for concentrated loads and **147** for distributed loads.

Compound Girders. *Compound girders* is the name given to those beams composed of one or more rolled joists with one or more plates added to the flanges. The simplest case is **148**, where a single plate is added to the compression flange, and others are shown in **149** and **150**, but it is always better to use plain rolled joists out of stock where possible, to avoid both the cost of riveting and the delay of waiting for it to be done.

Rolled Joists with Separators. When two or more rolled joists are used side by side, it is convenient to bolt them together by means of bolts passing through the webs and through cast-iron distance pieces or separators, as in **151**, to fix them at the required spacing. The holes, being through the web, do not reduce the theoretical strength, and virtually increase the practical strength by compelling the joists to share the load equally where circumstances may throw rather more upon one of them.

Plate Girders. Before the advent of rolled joists it was customary to build up girders by riveting together wrought-iron plates and angle-irons, as in **152** and **153**, and they are still made in this form of steel when rolled joists cannot be obtained of sufficient size. The webs may be of solid plate or of lattice bars arranged in various ways. Plate web girders with single webs, or box girders with double webs, are suitable for spans up to 50 ft., but beyond that lattice bars are more economical, as they can be proportioned more closely to the stress upon them. The bending moment at any point of a plate girder divided by the depth from centre to centre of the flanges gives the stress in each flange at that point, and the stress divided by the working allowance per square inch gives the number of square inches required in the effective sectional area. In the compression flange the effective area will be gross area, as the rivets fill the holes and offer solid resistance. In the tension flange, however, the rivet holes across the section must be deducted, as they reduce the tensile strength by the amount cut away. It thus happens that in wrought iron, with an allowance of 4 tons per square inch compression and 5 tons per square inch tension, the two flanges will be about equal, the less stress coming on the gross area and the greater stress upon the net area. In steel, when the allowance is equal in tension and compression a slight reduction may be made in the area of the compression flange. It is usual to count one side of the angle-irons as part of the flange.

Use of Parabola in Designing. With a rolled joist there is an inevitable waste of metal, because the section is uniform throughout, and must be sufficient to resist the maximum bending moment, which occurs at one point only. With girders having the flanges composed of several plates it is possible to adjust the sectional area very closely to the required amount, by letting the inner plates run through and stopping off the outer plates, as in **164**.

Cast-iron Stanchions. Cast-iron solid stanchions of + or H section are now only used in small and unimportant work. They may be calculated by Gordon's formula

$$W = \frac{6s}{1 + \frac{3l^2}{800d^2}},$$

where W = safe load in tons, s = sectional area in square inches, d = least diameter in inches, l = length in inches; but it will, in general, be sufficient to proportion the sectional area as follows:

Up to	8 diameters long	= 5 tons per sq. in.
,,	10 ,, ,,	= 4 ,, ,,
,,	12 ,, ,,	= 3 ,, ,,
,,	15 ,, ,,	= $2\frac{1}{2}$,, ,,
,,	18 ,, ,,	= 2 ,, ,,
,,	24 ,, ,,	= $1\frac{1}{2}$,, ,,
,,	30 ,, ,,	= 1 ,, ,,

Cast-iron Hollow Columns. These may be calculated by Gordon's formula as above, but with a constant of $\frac{1}{800}$ instead of $\frac{3}{800}$, or with a thickness of $\frac{1}{12}$ diameter the safe load may be taken as:

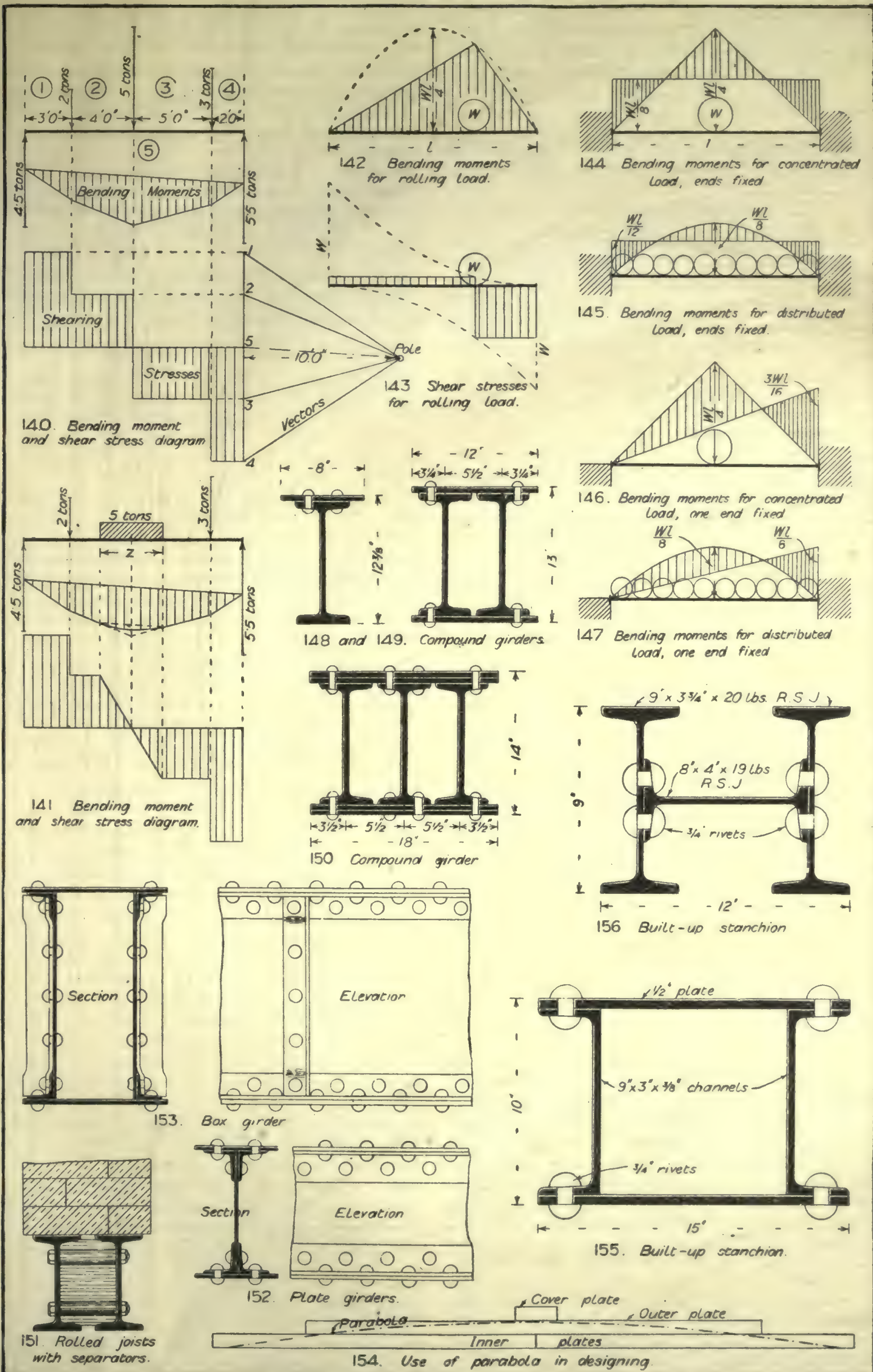
10 to 15 diameters long	= 4 tons per sq. in.
15 ,, 20 ,, ,,	= 3 ,, ,,
20 ,, 25 ,, ,,	= 2 ,, ,,
25 ,, 30 ,, ,,	= $1\frac{1}{2}$,, ,,

Rolled Joists as Stanchions. Only a few of the ordinary sections of rolled joists are suitable for stanchions, owing to the great difference in the moment of inertia in the two directions. For instance, the 14 in. by 6 in. by 57 lb. section has a vertical moment of 520·65 and a horizontal moment of 30·73, whereas for maximum efficiency it should be equal in both directions. One of the best sections is the 9 in. by 7 in. by 58 lb., which has moments of inertia of 216·81 and 46·59 respectively. The most suitable sections are the *differdange* or broad flange beams made by H. J. Skelton & Co. In these up to 12 in. deep, the width of flange is equal to the depth of beam, and the larger sections have a constant width of 12 in. The carrying capacity, with an axial load, is usually determined by the Rankine-Gordon formula for struts,

$$W = \frac{fA}{1 + \frac{l^2}{cr^2}},$$

where W = safe load in tons, f = maximum working stress in compression on short specimen in tons per square inch = 6 for mild steel, A = sectional area in square inches, l = length in inches, c = constant = 36,000 for ends flat and fixed, 24,000 for one end rounded or free to bend, and 18,000 for both ends rounded, r = radius of gyration.

Radius of Gyration. The objection to the simple Gordon formula is that the calculated strength from the ratio of length to least diameter does not agree with experiment so well as the ratio of length to radius of gyration



140. Bending moment and shear stress diagram

141. Bending moment and shear stress diagram.

142. Bending moments for rolling load.

143. Shear stresses for rolling load.

144. Bending moments for concentrated load, ends fixed

145. Bending moments for distributed load, ends fixed.

146. Bending moments for concentrated load, one end fixed

147. Bending moments for distributed load, one end fixed

148 and 149. Compound girders

150. Compound girder

151. Rolled joists with separators.

152. Plate girders.

153. Box girder

154. Use of parabola in designing

155. Built-up stanchion.

156. Built-up stanchion

STRENGTH OF BEAMS AND GIRDERS

which is substituted in the Rankine-Gordon formula. The radius of gyration is the square root of the quotient after dividing the moment of inertia by the sectional area, or

$$r = \sqrt{\frac{I}{A}};$$

but as the square of the radius of gyration is required in the formula it may be stated as

$$r^2 = \frac{I}{A}.$$

Calculation of Strength. Take, for example, 9 in. by 7 in. by 58 lb. rolled steel joists. The sectional area is 17·05 sq. in., the vertical or greatest moment of inertia is 216·81 in square inch units, and the horizontal or least moment of inertia is 46·59 sq. in. units ; then,

$$r^2 = \frac{I}{A} = \frac{216 \cdot 81}{17 \cdot 05} = 12 \cdot 7,$$

and

$$\frac{46 \cdot 59}{17 \cdot 05} = 2 \cdot 73.$$

Assume the stanchion to be 12 ft. long, then

$$W = \frac{fA}{1 + \frac{l^2}{cr^2}} = \frac{6 \times 17 \cdot 05}{1 + \frac{144^2}{36000 \times 12 \cdot 7}} = 97 \cdot 8 \text{ tons}$$

safe axial load if the stanchion is prevented from bending in the plane of either flange, or

$$\frac{6 \times 17 \cdot 05}{1 + \frac{144^2}{36000 \times 2 \cdot 73}} = 84 \cdot 5 \text{ tons}$$

if free to bend in either direction. The tabular value of ultimate strength in the manufacturers' catalogues is given as 338 tons, with a factor of safety of 4 for stationary loads and 6 for live loads, making the safe loads respectively $\frac{338}{4} = 84 \cdot 5$ tons and $\frac{338}{6} = 56 \cdot 3$ tons, showing the agreement of the tabular load with calculation.

Limiting Stress per Square Inch. It must be observed that the greatest safe loads according to the direction of bending being 84·5 tons and 56·3 tons respectively, the limiting stress per square inch for a stanchion of *this section and length* will be $\frac{84 \cdot 5}{17 \cdot 05} = 4 \cdot 96$ tons, and $\frac{56 \cdot 3}{17 \cdot 05} = 3 \cdot 3$ tons.

Non-axial Loads. There are very many cases in practice where the load is not axial, but is applied at one side of the rolled joist section, as where a stanchion is continuous through one or more floors, and the floor girders are attached by brackets or angle-irons to the flange or web of the stanchion. In these cases, a bending moment is caused in addition to the direct stress due to the load. It is a popular fallacy that when the girder is attached to the web of the stanchion the load is transmitted down the centre, and no bending moment results. This, however, is contrary to fact, and although the leverage to the centre of the bearing may not exceed 2 in., a very serious additional stress is put on the stanchion, and the tendency to bend is in the direction of the least moment of inertia or radius of gyration. Taking the same rolled joist as before, if a load of 17 tons be applied at a distance of 2 in. from the centre of web, the bending moment will be 17 × 2 = 34 ton-inches, and the compressive stress on the edges of the flanges will amount to $\frac{W}{A} + \frac{M}{Z}$, where W is the load in tons, A the area in square inches, M the bending moment, and Z the modulus of section, often wrongly called in many catalogues, "the moment of resistance in square inches." $Z = \frac{I}{y}$, and in the present case of 9 × 7 stanchion loaded on the web,

$$Z = \frac{46 \cdot 59}{3 \cdot 5} = 13 \cdot 31.$$

Then

$$\frac{W}{A} + \frac{M}{Z} = \frac{17}{17 \cdot 05} + \frac{34}{13 \cdot 31} = \cdot 997 + 2 \cdot 554 = 3 \cdot 551$$

tons per sq. in.

But it has already been shown that the limiting stress on this stanchion when free to bend in this direction is 3·3 tons per square inch, so that the stress with the load of 17 tons is just over the desirable limit. On the other hand, the load may be carried from one flange of the stanchion so as to utilise the greatest moment of inertia. Then, allowing half the depth of section, 4½ in., and 2 in. more to centre of bearing surface, the bending moment will be 6·5 × 7 = 110·5 ton-inches. The modulus of section will now be

$$Z = \frac{I}{y} = \frac{216 \cdot 81}{4 \cdot 5} = 48 \cdot 18,$$

and

$$\frac{W}{A} + \frac{M}{Z} = \frac{17}{17 \cdot 05} + \frac{110 \cdot 5}{48 \cdot 18}$$
$$= \cdot 997 + 2 \cdot 293 = 3 \cdot 29 \text{ tons per sq. in.},$$

but the allowable stress in this direction is 4·97 tons per square inch, so that it leaves an ample margin of safety, although the load is further from the axis of the stanchion.

Stanchions for Heavy Loads. When the load applied at the side of a stanchion exceeds 20 tons, it will in general be necessary to use a built-up section, and care should be taken to provide the requisite area with the least amount of riveting. It should also be noted that the material is more effective when disposed round the circumference rather than towards the centre ; thus, two channels and two plates, as in **155**, or three rolled joists, as **156**, form economical sections. The exigencies of space, however, sometimes compel the opposite extreme to be followed, and a solid section becomes necessary.

Continued

PETTY CASH

Methods of Recording Petty Cash Items. Tracing Errors. The Memorandum Petty Cash Book. Trade Expenses. The Imprest System

Continued from page 1969

By A. J. WINDUS

IN resuming our study of the synopsis on pages 1750 and 1751 it is desirable to examine transaction (*a*) in its relation to the petty cash book. There are two ways of treating this book. By some it is regarded as a mere memorandum book in which to enter day by day, or whenever the notion seizes them, payments which are considered too insignificant for individual entry in the cash book. At the end of each week, month, or other period, these payments are summarised, and the summary figures carried to the cash book. Thus the table on page 1968 informs us that for the week ended Aug. 6th, 1904, certain trade expenses totalled £1 11s. 2d. The amount is accordingly shown on the credit side of the cash book on the succeeding page to that on which the table appeared, and the details have been noted in a memorandum book as follows:

1904					
Aug. ..	2	Stamps		5	
	3	Fares, West End			6
		Gratuity to Carman ..			2
		Book of telegram forms ..		10	2
	4	Blotting paper		1	
		String			8
		Crate wood for cases ..		7	2
	5	Advt. in P.O. Directory ..		5	
	6	Carr. on goods from Lebus		1	6
			£1	11	2

Petty Cash Items. This method of recording petty cash expenditure is an improvement upon the former practice of passing petty cash items through the journal. There is, however, a serious objection to the memorandum petty cash book. It constitutes a weak spot in any system of bookkeeping because it is not properly interlinked with the other counting-house records. Books of original entry are temporary halting-places for items on their way to the ledger. It is here that transactions and transfers have debit and credit values assigned to them, and these values must be passed to their final resting-place in the ledger. The penalty for default is that the ledger will not balance, and a not less serious consequence is that the ledger will be destitute of information which it ought to contain.

Items in books of original entry may be compared to travellers who reach a common goal by different roads. Their entry into the sectional journals marks the penultimate stage of their journeyings. It is here, also, that they are marshalled into two great classes—debits and credits. From this time onwards the debits are not allowed to mingle with the credits, but must keep to one side of the road while the latter take the other side. Even when they arrive at their journey's end, the two classes will remain separate—debits to the left, credits to the right of the ledger folios.

A further rule which is derived from the classification just referred to is that no debit will be allowed to enter upon this stage unaccompanied by its proper credit, and vice versâ. The rule is most stringently enforced, and admits of but two exceptions, which do not, however, vitiate the underlying principle, but merely modify its application. The first exception is designed to meet the case of a number of debits equivalent in the aggregate to a single credit. A clear indication of the bond that unites them is accepted in lieu of literal compliance with the rule. First the debits are conveyed one by one to their destination in the ledger, and then the sole credit is transported thither. The other exception is permitted in the case of a number of credits equivalent in the aggregate to a single debit, and the procedure is similar to that described for the first exception.

Tracing Errors. Hence the regular admission of items into a journal is in itself a sort of guarantee that they will find their way in due course to the ledger. If they are posted wrongly, or not posted at all, the two sides of the Trial Balance will fail to agree, search will be made for the difference, and errors and omissions will be laid bare. For all that, a trial balance is not an infallible test of the accuracy of the bookkeeping. It will not, for instance, reveal an error in posting an amount to the debit of A's account which should have gone to the debit of B's account, and it is often powerless against what are called compensating errors. Thus, if the credit balance on Bills Payable account in the epitome at page 1750 were extracted as £55 14s. 11d., while at the same time the debit balance on Salaries and Wages account were set down as £11 19s., the Trial Balance—being correct in all other respects—would show an absolute agreement between the debit and credit totals, and yet in preparing a Balance Sheet and Profit and Loss account therefrom the liability under the head of Bills Payable would be overstated by 10s., as would also the business expenses under the head of Salaries and Wages. The one error compensates the other. The risk of posting items to wrong accounts cannot be wholly avoided, but the true safeguard against such errors remaining undiscovered is the careful checking from time to time of all ledger postings by calling them over with the original entries in the journals. Experience has proved this to be a wise precaution, but it is one that is too often neglected by bookkeepers.

Memorandum Petty Cash Book. Now, the memorandum petty cash book is not a book of original entry in the technical meaning of the term. It bears the same relation to the cash book—the real book of original entry for the item of £1 11s. 2d.—as the waste book does to the journal. Its entries may affect the ledger indirectly because of the difficulty of verifying the cash balance if they were not taken into account, but in practice the keeping of a memorandum petty cash book too often resolves itself into an attempt, or a series of attempts, to overcome the hiatus between the amount of cash that ought to be in hand according to the cash book and the amount actually present in the cash-box. The cashier is in truth the victim of a complicated system of dealing with the cash and of recording cash transactions.

Not only is it very easy under such conditions to lose sight of, or to forget to note down, an item in the memorandum book, but there is a temptation to "lump" together items which really belong to different accounts. The correct allocation of petty items is a tedious, and may seem a trivial task, in view of the smallness of the weekly or monthly totals. Nowadays, however, the margin of profit is so narrow, and competition so keen, that it becomes imperative to analyse expenditure exhaustively, so that waste and extravagance may be detected and for the future prevented. Let us see, for example, how the distribution of petty expenditure would be made in the case before us.

A summation of the items in the memorandum cash book for the week ended August 6th, 1904, would be made. Then the total of £1 11s. 2d. would be apportioned as under:

	£	s.	d.
Postages and telegrams ..		15	2
Packing materials		7	10
Carriage		1	6
Advertising		5	0
Printing and stationery ..		1	0
Trade expenses			8
	£1	11	2

Instead of entering one item of £1 11s. 2d. in the cash book, we should now enter six items aggregating that amount, writing opposite each item the name of the account to which it belonged. Finally, the items would be posted to their appropriate accounts in the ledger.

Trade Expenses. It may be stated in passing that Trade (or Office) Expenses account is an account of miscellaneous items, trifling in amount and of infrequent occurrence. The total amount standing to the debit of Trade Expenses account at the end of a given period represents, in fact, a residuum of expenditure which cannot fairly be charged to specific expense accounts, having been incurred for the benefit of the business as a whole.

The petty cash book has always been the subject of a certain amount of misconception in the minds of many people because of its title. It is said—but the statement is inexact—that the petty cash book is a record of items which are too insignificant to be passed through the cash book. That may have been so originally, but to-day we find the petty cash book performing the functions of a true cash book—items appearing therein of salaries, wages, commissions, travelling expenses, and the like, which represent quite respectable sums of money, as well as items of genuine petty expenditure. Perhaps, if the word "office" were substituted for the word "petty," so that we might distinguish the cash registers as bank cash book and office cash book respectively, we should get rid of the idea that the petty cash book is of merely minor importance.

It is this idea which for a long time prevented the petty cash book being treated as a journal; but when, on the one hand, the need for analysing the petty cash became apparent, while, on the other hand, bookkeepers were dismayed at the extra labour involved, the possible direct relationship of the petty cash book to the ledger was inquired into more closely. The result was that changes and developments have occurred in the character of the former, culminating in the analysis petty cash book as illustrated at page 403.

The Imprest System. Before dealing with that, however, let us briefly consider one or two of the other methods of recording petty cash transactions which are in use at the present time. First, there is the imprest system. The petty cashier receives an open cheque for a round sum of, say, £10, which amount the cashier enters on the credit side of the cash book, charging petty cash account therewith. Presently the ledger keeper opens an account for petty cash with the debit of £10 posted from the cash book. The petty cashier having cashed the cheque, puts the proceeds in the cash-box. From the fund thus provided he makes payments not exceeding the authorised limit for any one payment. At the end of the month—or earlier, should his balance happen to be running low—he totals the payments made since he received his latest advance, and rules the amount off thus:

1904				
Jan. 1	Stamps		5	
2	&c.		&	c.
&c.				
	Total for January	£8	14	3

His next care is to analyse the total, which done, he takes his analysis together with vouchers in support of his expenditure, to the cashier, who examines the figures with the vouchers, and, finding them correct, in due course hands the petty cashier an open cheque for the exact sum stated to have been expended—namely, £8 14s. 3d. The analysis is retained by the cashier, who, instead of entering £8 14s. 3d. as a payment, copies from the analysis into the cash book the several sums that go to make up the amount of the cheque, and from

the cash book these items would eventually be posted to the ledger. The petty cashier, having cashed the cheque for £8 14s. 3d., adds the proceeds to the money in the cash-box. If no payments have been made in the meantime, it will be found that the cash in hand has now been restored to its original amount of £10.

At the end of January there should have been £1 5s. 9d. in the cash-box (£10 less £8 14s. 3d.), therefore an addition of £8 14s. 3d. thereto would replace the petty cashier at the beginning of February in the position he occupied on January 1st, of a debtor to his employers for the sum of £10 advanced for petty cash.

From the new fund thus formed he continues to make payments until the time comes to approach his chief for more money, when the same routine is observed as before.

As a consequence of the method now explained, the registration in the petty cash book of cheques received by the petty cashier is rendered unnecessary. There is no difficulty in testing the cash balance, because this must always coincide with the difference between the recorded current expenditure and the floating debt of £10. Thus, if up to February 15th the petty cashier has expended, according to his cash book, £5 9s. 2d., he ought to have £4 10s. 10d. in hand.

Advantages of the Imprest System. The advantages of this method from the administrative point of view are that it establishes a salutary control over the petty cash expenditure, and that it ensures, if faithfully carried out, the lodgment intact of all sums from outside sources which have been registered in the cash book. In the latter respect the system is similar to that recommended on page 977, but the petty cash book differs from that shown on page 403 in that the analysis figures are not posted to the ledger direct, but through the cash book, whereas the columnar totals of our tabular petty cash book are posted direct.

There is, however, nothing to prevent the petty cashier, with his chief's permission, making the periodic analyses in the petty cash book itself, thus enabling the ledger keeper to use it as a book of original entry from which the ledger postings could be made. If this were done, the cashier would merely enter in the cash book the amounts of the petty cash cheques, against which references to the petty cash book would be inserted in the folio column. The inquirer, on turning to the places in the petty cash book which had been pointed out in the cash book, would find that the amounts entered in total in the latter had been dealt with in detail in the former. But the initial £10 would be posted to the ledger direct.

The petty cashier might go even further than this by approximating the form of his cash register to that of the tabular petty cash book through the addition of analysis columns. By this means the labour of the monthly dissections of expenditure would be reduced and simplified.

The "cash" columns in the cash book illustrated on page 1969 are indicative of a method of stating cash transactions which has already been dealt with. A variation of the method may be obtained by pressing these "cash" columns into the service of petty cash. This is done by those who deny the utility of a separate book for petty cash. Instead of a single amount for £1 11s. 2d. appearing in the "cash" column as trade expenses for the week ended August 6th, particulars of the items making up that amount would be interspersed among the narratives of other payments, the amounts themselves being entered in the "cash" column. The scheme has at least this advantage over the plan of keeping a memorandum book for petty payments—namely, that by abolishing this book it also destroys the unreal distinction between cash and petty cash, and enables a better control over the cash in hand to be maintained.

Some Disadvantages of the Scheme. The obvious disadvantage of the scheme is that it involves the individual posting of a large number of small amounts which in other circumstances would be summarised, only the sub-totals obtained thereby being posted to the ledger. The difficulty might be partly overcome by reserving an extra column on the credit side of the cash book for petty payments which could be totalled and dissected at convenient intervals, and the resultant figures carried into the "cash" column, from whence they could be posted to the ledger.

We may notice an alternative method to the imprest system of managing petty cash transactions, where moneys from outside sources are banked punctually, and without any deduction. This consists in keeping a separate petty or office cash book ruled with debit and credit columns, wherein all receipts of money from the bank and all payments except those made by cheque are duly recorded. There is no floating balance in this case, but amounts of £5 are drawn from the bank as often as they are wanted, and added to the cash balance. Except that in many cases there are no analysis columns in the petty cash book, this system is identical with that which now falls to be described.

A careful comparison of the various modes of handling and recording cash and petty cash should lead us to give our verdict in favour of the analysis, or tabular petty cash book already mentioned. If we subscribe to the scientific truth that progress is always from complexity to simplicity, then we shall agree that the highest, because the simplest, form of petty cash book which has come within our knowledge is the one shown on page 403. To it, and also to the bank cash book on page 779, the student is now asked to refer.

The Tabular Petty Cash Book. In pursuance of the policy of having every account in the ledger, an account for petty cash has been opened on folio 25 of Messrs. Bevan & Kirk's general ledger. The first item on the debit side is the balance of 10s. as at September 1st, 1905, and the amounts drawn from bank during the month, as ascertained from the bank cash book, follow in

chronological order. The result should be a total debit of £90 10s., corresponding with the total of the "received" column in the petty cash book. On the credit side, the total expenditure for the month, as ascertained from the petty cash book, has been posted in one sum—*viz.*, £89 13s. 1d. The account has been balanced off, and the balance of 16s. 1d., which agrees with that shown in the petty cash book, brought down to the October account.

The petty cash account in the ledger is nothing more than an epitome of the petty cash book, and might, therefore, be dispensed with but that it affords a check upon the amounts shown in the "received" column of the petty cash book, and is useful for other reasons. Bearing in mind what was said as to the bank balance and the cash in hand constituting two portions of one fund, we see clearly why the transfer of money from bank to petty cash has the effect of debiting petty cash account and crediting bank account, and nothing further need be said concerning such transfers.

Treatment of Payments from Petty Cash. With regard to payments from petty cash, we notice that these, after being entered in the "paid" column, have been analysed under various heads. It should be pointed out that unanimity among business men in the matter of the particular accounts to which items of expense should be apportioned cannot be expected, and does not exist. But there are some rules which are of general application, and should be adhered to.

An example of what is meant occurs in Messrs. Bevan & Kirk's petty cash book. Under date of Sept. 27th, we have the item "Advertisement for salesman, 3s." It would be wrong, but the mistake is often made, to treat an item of this kind as a debit to Advertising account, because that account is opened for the specific purpose of showing the expenditure incurred in making known the firm's business to the utmost possible extent. What bearing has the advertising for a salesman or clerk upon the increase of business expected to flow from a well-ordered advertising campaign?

The Ledger Postings. We shall number the money columns to the right of the "paid" column in the petty cash book 1, 2, 3, 4, 5, 6 respectively. It having been shown that the cross-casting of the totals of all these columns is equivalent to the total amount expended, nothing now remains except to note the ledger postings. Jones & Co., Wm. Smith, and the Berlin Manufacturing Company are manufacturers for whom Bevan & Kirk act as agents. Out-of-pocket expenses paid from petty cash, and chargeable to all or any of them, are shown in columns 1, 2, 3, and pains must be taken to see that items are placed in the right columns. The special vice of the columnar system of bookkeeping is the risk of items getting into the *wrong* columns. The references at the foot of columns 1, 2, and 3 inform us that 7s. 2d. has been posted to the debit of Jones & Co.'s account in the general ledger (G.L. 51), 10s. 2d. has gone to the debit of Smith's account (G.L. 53), and 3s. 4d. to the debit of Berlin Manufacturing Company's account on G.L. 55.

The total of column No. 4 has been posted to the debit of Trade Expenses account, and we shall not be slow to admit the utility of the tabular method when we reflect that if all the items had been posted singly they would probably have occupied from forty to fifty lines in the ledger, while, if the petty cash had been summarised, the grouping of all the items would yet have proved a troublesome task.

Postage Column. Column No. 5 is reserved for stamps. By this means a check upon the postboy is established, as will be seen. The monthly total of the postages column appears as a debit on Postages account (G.L. 29).

The last column is headed "Sundries," and contains all the items which do not belong to any of the other columns. These are posted, not in total but in detail, and therefore a special folio column is provided to admit of the insertion of ledger references.

We may refer to Transaction (*b*) in the synopsis for the sake of completing our remarks on Bevan & Kirk's postage book.

"Sept. 20, stamps purchased, 5s."

The postage book kept by Bevan & Kirk's junior clerk is a miniature of the firm's petty cash book, and the rules laid down for the latter will apply equally as well to the former. The Postage account in the General ledger already stands debited with £2, and, assuming the stock of stamps to have run out on Aug. 31st, this amount would represent the total debit for September corresponding with the total of the "received" column in the postage book. On the credit side, post the total expenditure for the month as ascertained from the postage book, say £1 19s., balance the account, and bring down the balance of 1s., which should agree with that shown in the postage book brought down to the October account.

"Received" Column of Postage Book. The entries in the "received" column of the postage book represent transfers from petty cash to postages, and may be checked at any time by comparison with the Postage column in the petty cash book. Such transfers have the effect of crediting Petty Cash account and debiting Stamps or Postages account.

The "paid" column of the postage book is analysed under the headings Jones & Co., Wm. Smith, Berlin Manufacturing Company, Office, Sundries.

The procedure as to cross-casting the monthly totals and posting them to their respective accounts in the ledger is precisely the same as that described for Bevan & Kirk's petty cash book.

Continued

MAKING A PRINCESS GOWN

The Fastenings. Boning and Linings. The Sleeves and Collar. Trimmings. Lapping Seams. Strappings

continued from p. 2059

By Mrs. W. H. SMITH and AZÉLINE LEWIS

THE front can either be made to button or have an edge to edge fastening. If the former, the inlay must be cut away to within ¼ in. on the buttonhole side, and ⅞ in. on the left side for the buttonstand. For the working of buttonholes see the instructions given in boys' tailoring.

If an edge to edge fastening, the inlay must be cut away on both sides to within ⅜ in. The edges must be turned in ⅜ in., and serged to the canvas only, very thickly, then stitched by machine quite close to the edge. The hooks and eyes must be sewn on alternately on both sides, not less than ¾ in. apart. The hooks should be $\frac{1}{16}$ in. in from the edge and the eyes $\frac{1}{16}$ in. out from edge. They must be sewn on strongly with fine thread. Well secure the opening.

We assume the fore parts to be prepared as in previous lesson—it must be remembered that we are giving exceptions only.

Baste all the parts together except the fronts. Be careful to keep waist line to waist line and notch to notch in every instance; if this is not done the back is liable to be passed up or down in the making, thereby destroying the balance and giving a lot of unnecessary trouble to put right.

The right half must be basted from bottom to top, and the left from top to bottom—*i.e.*, the curved parts must always be underneath. This also applies to the machining. Baste the seams thickly, as on this largely depends the success of the garment.

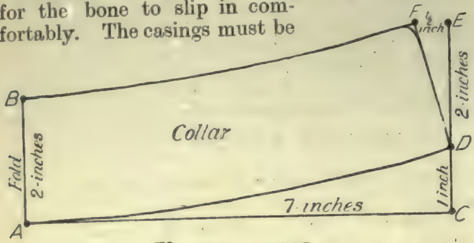
The seams after being stitched must be treated in the same manner as the ladies' tight-fitting jacket.

Boning. Put the whalebone in cold water to soak while the seams are being prepared with the casings. Prepare ten or twelve strips of canvas on the bias, 1 in. wide and about 8½ in. long. Baste a strip on each seam, beginning 2½ in. below bust line, and keeping it well eased at the waist; secure to the edges of seams. Now cut the linen through from corner to corner to obtain the bias; cut ten or twelve strips 1½ in. wide and about 8½ in. long, and fold each through the centre. They will now be ¾ in. wide.

Begin with the back; place one of the strips ⅜ in. on either side of the centre of seam and baste, keeping it easy above and below waist, and so on with each strip.

71. SOME STYLES EVOLVED FROM THE PRINCESS GOWN

The linen must be half back-stitched to the canvas on both sides, leaving sufficient room for the bone to slip in comfortably. The casings must be

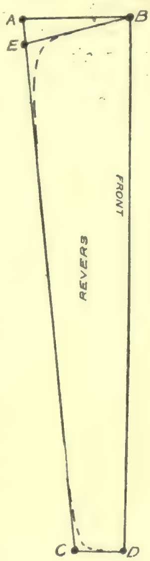


70. THE COLLAR

left free 1 in. at the top and ½ in. at the bottom, and the latter stitched to prevent the bone coming out.

When the bone is sufficiently pliable, pierce holes 1 in. from the top of each piece and ¾ in. from the bottom. They should be ¼ in. longer than casing. The ends must be pared round or they will cut through the garment.

Now take a piece of the bone, and bend it with the thumb and finger to make it curve well in the hollow of waist. Place it in the casing, pushing it down well through the fulness at the waist, and securing it to the casing top and bottom through the perforations, and again 2 in. above the waist line. Sew up the top of casing, and treat all the seams in the same way.



72. DRAFTING REVERS

The Darts. The darts must be prepared in the same manner, but the casing must be left free 1½ in. below the top of dart and well eased in the hollow of the waist. Insert the bone and secure the top. Both darts are so treated. The fronts also will require boning for edge to edge fastenings.

Now baste the forearm to side; stitch the seam, open, and press; insert the casing and bone as described for the other seams.

Place a little wadding in the front of armhole, the shape of a dress preserver [69, page 2059]; it must be thinned away at the edge from end to end. Close the shoulder as in previous lesson, then stitch up front as far as seat line; press and finish as before.

We are now ready for the canvas for the bottom of robe. This must be cut the same shape as the gores, and not less than 4 in. deep. Each piece must be basted to its corresponding gore and well secured to each seam.

It can be stitched with as many rows of stitching as preferred, beginning ½ in. below the top of canvas. The stitching adds to the beauty of the robe, providing the rows are kept even. Turn the bottom up and serge to the canvas.

Place a damp cloth over and shrink out all the fulness with a hot iron, lifting the bottom occasionally to let the steam escape.

Having done this, we are ready for the lining.

The Lining. Place waist line of lining to waist line of robe, and secure to each seam. Be sure and put it in "easy" in length and width. Baste the lining to the front under the hooks, keeping it quite easy at that part.

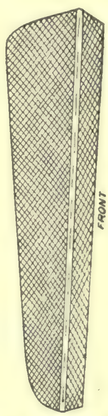
Now baste the lining to the top of inlay at the bottom of robe, and fell.

A wrap about 1½ in. wide should be secured to the left side from the neck to opening; it must be secured here and there to keep in position, and must be pressed and made neat before putting on.

For the sleeve, the reader should refer to the instructions given on page 2056. If preferred, it may be cut off to the elbow and have a gauntlet. In this case, a little more fulness will be required at the elbow, to be eased in [*c* and *d*, 71].

The Collar. The collar should be of stiff collar canvas. For the pattern, see diagram 70.

It is advisable to place the canvas between two pieces of thin lining and stitch it all round and through the centre. Allow ¼ in. turnings on the cloth; baste to the collar and serge the edges thickly to the lining; mitre the corners to make them thin, and either stretch or nick curved part as from B to F; remove the basting and press.



73. REVERS LINING

Sew on two hooks and eyes to match the front.

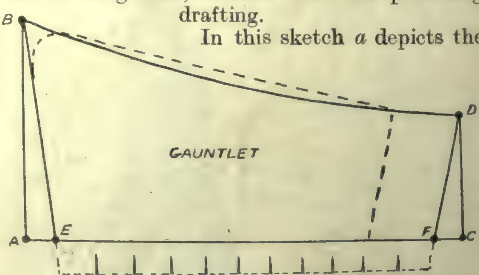
Attach the collar to the centre of back, and the ends even with the fronts. Baste to the neck from the inside, holding it well over the hand. The hollow of the neck should be stretched a little.

It is advisable to sew the collar on by hand, and line either with a piece of the same lining as robe, or with silk. Secure two hangers at the back of armholes, as at I[a].

This completes the making of the plain robe, but it can be dealt with in many ways, and converted into various garments—from a dressing to an evening gown, as the following will show.

Diagram 71 presents some gowns for day and evening wear, evolved from the preceding drafting.

In this sketch *a* depicts the



74. DRAFTING GAUNTLET

gown of the drafting, fastening at the side, with only graduated strapping on the side-seams of

bodice as trimming. If this style is preferred, the centre front must be placed to the fold, and an inlay left on the left fore part from M^b to the bottom. To do this, it will be best to cut the left fore part through the dart and the side nearest armhole separately, so that the inlay can be left on in the cutting.

The fastening should have a strapping to hide it, and the right dart must, of course, be strapped to match.

b shows the same gown, with the addition of revers of velvet, edged with silk or gold cord and lace, and a pointed velvet vest-piece at neck and waist, also edged to match.

The sleeves have gauntlet cuffs to correspond, whilst the edge of the skirt is trimmed with a band of velvet, with deep Vandyke lace or passementerie above this, with the points turning upwards. The making of the gown follows the directions already given, the pointed vest-pieces being added before finishing the fronts. The making of cuffs and revers will be considered later.

Another pretty and very favourite style is the corselet skirt, which is also evolved from our drafting. In this case, all that is required is to cut the top to the bust line, or according to the height required, and then curve this as taste and fashion may dictate. Our diagram (*c*) gives a suggestion for such a gown to be worn over a blouse, with straps extending over the shoulders, edged with spotted velvet trimming, which also edges the three shaped tucks at the foot part of skirt. The making of shaped tucks has been described in Dressmaking. They are cut to the shape of the skirt and unlined, the edge being turned up on the right side and neatened with the trimming. The fastening in this model is at the back, but the making is exactly the same as for the front fastenings.

The same model appears in *d* of the diagram, worn with a smart little bolero for out-of-door wear. The sleeves in both models are to the elbow, but we think the student will hardly require to be told that the sleeve of our drafting [59] will do for this, and may be cut any length desired.

76. SEAMS READY FOR STITCHING

On the left, *e* gives a handsome model of the *grande dame* order, which is for evening wear, evolved from our drafting. This is cut to the requisite neck depth, either with or without shoulder straps, and is carried out in velvet of the chiffon or ordinary make, although satin or brocade, or even the finest panne cloth, are equally suitable. It is trimmed at the neck with handsome pointed lace and a fold of tulle.

75. FIRST STAGE OF LAPPING

The skirt is longer than the others, but the manner of obtaining this should present no difficulty to those who have followed this course, as well as that of the Dressmaking, whilst the remarks there given as to the pressing of velvet should be followed in the making of this gown, the very greatest care being necessary.

If satin, brocade, or pile goods be used, shrinking is not possible. The fastening may be accomplished at either back or front, by means of edge to edge fastenings or eyelet-holes and lacing, as preferred. This last dress, whilst not, perhaps, tailor-made in the strict sense of the word, is included here because the making of such a robe in its very simplicity of outline demands those qualities of cut and accuracy, as well as perfection of fit and make, which distinguish the best tailor work.

Having studied the making of the plain garment, we must now turn our attention to the various ways by which it can be adorned—by means of revers, cuffs, strapping, etc. We will, therefore, first consider the revers which trim the bodice of the Princess Robe of *b*, in **71**.

Drafting. A piece of paper 18 in. by 6 in. will be required.

Square lines at right angles ½ in. from top and ½ in. from edge.

A to B, 3½ in.; A to C, the length required—in this case 18 in.; C to D, 1 in. Connect B to D, and A to C.

A to E, ¾ in. Connect E to B. Round the corners as in the sketch, or leave them pointed if preferred, as this is a mere question of taste. Cut the pattern round the outline [72].

Materials Required. ½ yd. of velvet, ½ yd. very fine vest canvas, ¼ yd. mull muslin. This will leave sufficient for the gauntlets.

Cut the canvas on the bias, allow ½ in. from B to D for turnings. Cut two pieces of muslin for each rever, the same size as canvas; this not only prevents the edges cutting through, but

gives a fulness or finished appearance to the revers when in position.

Place the canvas between the muslin and baste together round the edges. Now place a narrow silk stay along the fold of rever as from B to D, taking care not to stretch the fold. A narrow ribbon, ¼ in. wide, makes a good stay [73]. Fold the velvet and cut both revers together, to ensure their being the right shade [see page 864].

Place the front of rever to the fold; allow ¼ in. turning round the outer edge. Baste the rever slightly with a fine needle and silk, to keep in position, keeping the velvet easy. Turn in the outer edges and herringbone to the muslin; over-sew the raw edges. Face the rever with silk and trim as desired; it is then ready to be sewn on. Baste to the bodice ¼ in. from the fold. [For position see *b*, 71.] When arranged to satisfaction, secure to the bodice.

Gauntlet for Princess Robe. For the drafting, a piece of paper 8 in. by 5 in. will be required [74].

Elbow measurement, 12 in. Working scale, half elbow, 6 in. Begin the drafting as for rever. A to B, 3½ in., or depth required. A to C, width of elbow, plus 1 in. (7 in.); C to D, 2 in.; curve from D to B. A to E, ½ in.; C to F, ½ in.; connect E to B and F to D. The broken lines show the turnings, which must be cut as shown, to prevent contraction when put on. The gauntlets are made in exactly the same way as the rever, but the bottoms of the sleeves must be finished off before they are put on.

Thinness and neatness are most essential points to observe in making gauntlets and revers.

The collar of the bolero in *d*, and the cuff in *b* of the same diagram, are but variations of this drafting, which the student should be able to manage, as well as all other shapes, whilst the making will follow the directions already given.

Lapping. We shall now consider a method of finishing seams which is known as "lapping," which, if well done, looks very smart and effective.

If the lapped seams are to have only one row of stitching on the right side—which is quite sufficient for a short jacket—¼ in. must be left over and above the thread-marks. If two rows are required, from ½ to ¾ in. will be necessary.

Baste the seams together, holding the work over the knee; stitch and press, as in previous lessons. It is important that the part left for the lap above and below the waist should be stretched. Cut the turnings away to within ⅛ in. of the stitching on the right-hand side of A, B, and C, and on the left of D and E [75].

Turn the garment over, right side uppermost; baste the centre back seam, working the edge slightly over the seam with finger and thumb; then baste again the width of lap.

Each seam must be basted in the same way, the left side as at F and G, the right side as at H, I, and J—*i.e.*, with the seams facing towards the fronts. Fig. 76 shows the seams basted ready for stitching. The shoulders must also be treated in the same manner. It should be remembered that the stitching must be done very evenly if it is to be a success.

After the seams have been stitched, remove the basting and well press on the wrong side, as the success of the lapping depends largely on the pressing.

An important item to deal with is the sleeve-head. We have to be very careful at this point, so that the continuous run, or course, of the armhole shall, when the garment is finished, be unimpaired. The shoulder seams must lap towards the back.

Another effective way of finishing the seams is to stitch them on either side ¼ in. from the seam after, of course, they are opened and pressed.

77. STRAPPING TACKED IN PLACE

If the cloth is thick and of a firm, close make, such as box-cloth, the seams are usually lapped raw-edged. In this case, the preliminary stitching together of the seams is omitted, the edges being placed one over the other and stitched together at each edge of the outline.

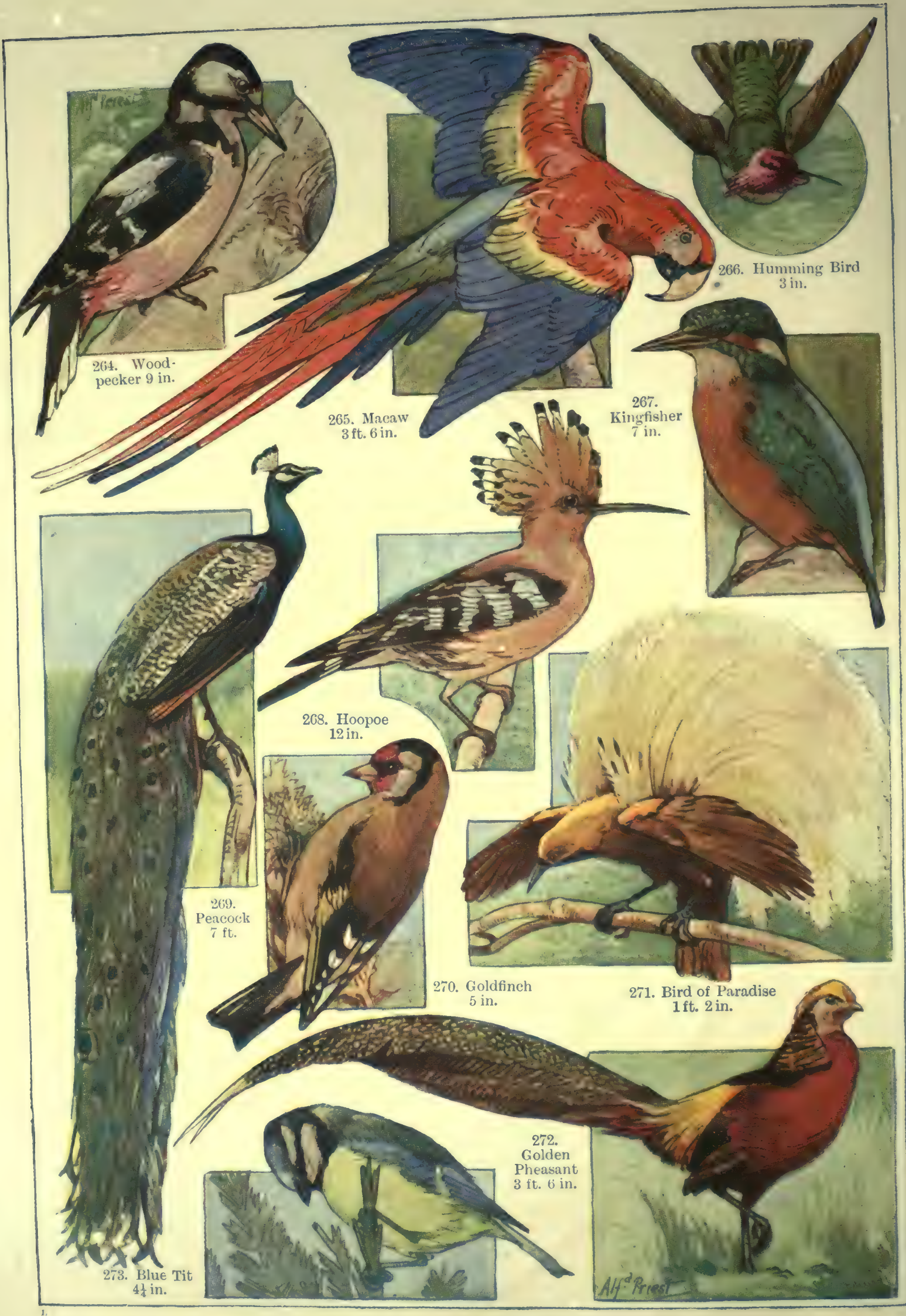
This method, however, requires the greatest care and accuracy in cutting and measuring, the former being done with large and very sharp scissors. As a wrong snip may totally ruin the garment, a coat with such lapped seams should not be attempted till the learner has shown herself capable of making a perfectly-fitting one with plain seams.

Strapping. A very pretty way of trimming a dress is to strap the seams. The straps are made in this way. They should be cut quite evenly, as wide again as they are to be when finished. The edges must be serged together lightly, holding the strap over the knee, and supporting it with the finger and thumb of the left hand. It is important to do this as directed, as, if the cotton is pulled tight, the mark of the serging will show all down the strap.

When the edges are finished, the strapping must be pressed flat with the serging in the centre. Now baste the strapping with the centre to the seam, holding the garment over the knee while so doing. This will keep the strapping long and prevent it contracting [77]. Stitch both sides of the strap ¼ in. from the edge, and baste in position, then secure it to the dress on the wrong side.

Strappings from ⅜ to ½ in. wide when finished make a very nice trimming for skirts, particularly if they are put on to form a design. For a dress, they are generally made from 1½ to 2 in. in width, and sometimes look well if piped with a contrasting colour. They can be made broader still for the fronts of a jacket, and have several rows of stitching, or may be varied in many ways.

Continued



SOME BIRDS OF BRILLIANT PLUMAGE

The size of each bird is the measurement from point of beak to tip of tail. [See NATURAL HISTORY]

CLASSIFICATION OF BIRDS

Flying, Running, and Extinct Toothed Birds, Grouped into Their Orders. Song Birds, Pigeons, Gulls, Game Birds, Eagles and Aquatic Birds

continued from page 2157

By Professor J. R. AINSWORTH DAVIS

BIRDS are vertebrates with hot blood (103° F., while mammals are 98° F.), and by the possession of feathers, and the alteration of their fore-limbs into wings, are clearly marked off from all other animals which now exist, though they resemble reptiles in many ways, and are undoubtedly derived from the same ancestral stock. The digits of the hand have been reduced to three, by loss of the fourth and little fingers, and there are never more than four toes in the foot, the little toe being always absent. No existing bird possesses teeth, though these were present in some very ancient extinct forms.

There are some 10,000 living species (as against under 3,000 mammals), which fall into two sub-classes—flying birds (*Carinatæ*) and running birds (*Ratitæ*).

Flying Birds. The flying birds include the vast majority of forms, and it is a difficult task to subdivide them into smaller groups, for the differences between them are often comparatively trivial, and it is impossible to draw the sharp boundary lines which we have seen to exist in mammals. The older naturalists relied solely upon structure as obviously related to habits, and spoke of swimming, climbing, wading, scratching, perching birds, etc.; but this method of classification is now considerably modified, for it brings together some species which only resemble one another in a very superficial way, and separates others that are nearly related. There is a very large number of families grouped into orders, and it will here only be possible to give a very brief review of some of the more important of them.

Order 1. Perching Birds
(*Passeres*)

The large order of perching birds, which is admittedly the highest, includes more than half (some 5,500) of the known species, and the bulk of British "small birds" are referred to it. The four-toed foot is adapted to perching—*i.e.*, firmly grasping boughs and the like, in accordance with which the backwardly-directed great toe bears a comparatively large claw and possesses unusual powers of free movement. This type of foot may be conveniently studied in a tame canary. The young are helpless, almost naked, nestlings, which require assiduous care on the part of their parents.

The "song birds" (*Oscines*), with some of their close allies not specially remarkable for vocal powers, head the long list of perchers. It is interesting to note that the "song box" (*syrinx*), which is the source of melody, does not correspond to the "voice box" (*larynx*) of mammals, for it is situated at the place where the windpipe forks into a branch for each lung, while the latter is the modified top of the same.

Finches and buntings (*Fringillidæ*) are small birds with a strong conical beak, well able to deal with seeds or with a mixed diet. The following are familiar British forms: Goldfinch (*Carduelis elegans*) [270], chaffinch (*Fringilla cœlebs*), bullfinch (*Pyrrhula europæa*), linnet (*Linota cannabina*), yellowhammer (*Emberiza citronella*), and house sparrow (*Passer domesticus*). In the less common crossbill (*Loxia curvirostra*) the upper and lower halves of the beak cross each other in scissor-like fashion, an arrangement which facilitates the extraction of seeds from the cones of pine, fir, larch, etc. The wild canary (*Serinus canarius*), native to Madeira, the Azores, and the Canary Islands, is of comparatively sober plumage, and very unlike the numerous breeds which have been produced by domestication and artificial selection.

The American starlings (*Icteridæ*) possess longer and narrower beaks than the finches, and are interesting because they include the cow-birds (*Molobrus*), some of which, like cuckoos, deposit their eggs in the nests of more industrious songsters. One South American species (*M. rufaxillaris*) takes advantage in this way of an allied species (*M. badius*), which constructs a nest in the orthodox fashion.

Weaver birds (*Ploceidæ*), most of which are African, though the family ranges east to Australia, are remarkable for the way in which they weave stalks and fibres into rounded nests with tubular entrances. The most familiar form seen in captivity is the Java sparrow (*Munia oryzivora*).

The creepers (*Certhiidæ*) are represented in this country by the active little tree-creeper (*Certhia familiaris*), which may often be seen making its way up mossy walls and tree trunks, searching for insect-food with its slender curved beak, and using its stiff tail feathers as a means of support.

The beautiful little sun-birds (*Nectariniidæ*), which range through the hotter parts of the Old World, are often mistaken for humming birds, owing to their brilliant metallic plumage and long, slender beaks. They render valuable service to many plants by transferring pollen from flower to flower.

The starlings (*Sturnidæ*) are chiefly to be found in Africa and India, but are represented in most parts of the Old World, and the common starling (*Sturnus vulgaris*) is familiar in this country. It is even to be seen so far north as Greenland. The long, pointed beak deals with animal food, but some species also eat fruit and seeds. In Africa, the ox-pecker (*Buphaga*)

devotes its attention to the ticks which infest cattle and other mammals.

The stout-billed crows and allied forms (*Corvidæ*) are represented in almost all parts of the globe, and their food is of miscellaneous character. The best-known British species are the raven (*Corvus corax*), carrion crow (*C. corone*), rook (*C. frugilegus*), jackdaw (*C. monedula*), magpie (*Pica rustica*), and jay (*Garrulus glandarius*).

The birds of paradise (*Paradiseidæ*) of the Australian region, despite their beautiful plumage [**271**] are closely related to the crows. Grouped with them are the more sober-plumaged bower birds, some of which are famous for the way in which they construct "bowers" for purposes of play, or even a "garden," which is made gay with flowers and berries, renewed as soon as they fade.

The pretty little insectivorous tits (*Paridæ*) are almost cosmopolitan, and haunt trees in search of their food. The blue tit (*Parus cæruleus*) [**273**] is, perhaps, the prettiest of our native species. The bearded tit or reedling (*Panurus biarmicus*) is now placed in a family of its own (*Panuridæ*).

Nut-hatches (*Sittidæ*), represented in Britain by the common nut-hatch (*Sitta cæsia*), resemble tits in habit, but are of somewhat larger size.

Shrikes (*Laniidæ*) have strong bills, often strongly hooked in relation to their carnivorous diet. Our commonest species is the red-backed shrike or "butcher bird" (*Lanius collurio*). The latter name has reference to the curious practice of impaling all sorts of small creatures in the neighbourhood of the nest, to serve as a "larder."

Swallows and martins (*Hirundinidæ*) are to be found practically all over the world, and furnish the most obvious British example of migratory species. Their marked powers of rapid flight, enabling them to catch insects on the wing, are associated with long, pointed wings, and a well-developed tail, often deeply forked. The short, broad beak can be opened very widely to receive the insect victims. The feet are small and feeble. There are three British species, the swallow (*Hirundo rustica*), with reddish throat and deeply-forked greenish tail, the white-throated martin (*Chelidon urbica*), and the sand-martin (*Cotile riparia*) which nests in sandbanks.

The wrens (*Troglodytidæ*), though very widely distributed, are most characteristic of the hotter parts of America. Our little native wren (*Troglodytes parvulus*), with its short, upturned tail, is often to be seen in hedges, using its slender pointed bill for the capture of insects and other small creatures, when these are to be had. In winter it largely feeds on fruits and seeds. A slightly larger kind of wren is limited to the island of St. Kilda, and regarded by some as a distinct species (*T. hirtensis*).

The water-ousels (*Cinclidæ*), which look something like stoutly-built wrens, frequent rapid upland streams, in which they dive for insects and small molluscs. Our native dipper (*Cinclus aquaticus*) belongs to the family.

The thrushes, warblers, and mocking-birds (*Turdidæ*) make up a cosmopolitan family, including many familiar forms, some of which are noted songsters. Among British species are the following: Song-thrush (*Turdus musicus*), blackbird (*T. merula*), wheat-ear (*Saxicola œnanthe*), robin (*Erithacus rubecula*), nightingale (*Daulias luscinia*), garden warbler (*Sylvia hortensis*), golden-crested wren (*Regulus cristatus*), our smallest native bird, and hedge-sparrow (*Accentor modularis*). The mocking-birds are American forms.

Wagtails and pipits (*Motacillidæ*) are among out best-known small birds. The former are typically Old World forms, distinguished by the jerky way in which they move their long tails up and down. Our commonest species is the water-wagtail (*Motacilla lugubris*), but the yellow wagtail (*M. raii*) is locally abundant. The shorter-tailed pipits are practically cosmopolitan, and are represented in Britain by a number of species, of which the meadow pipit (*Anthus pratensis*) is typical.

Larks (*Alaudidæ*) are mostly Old World forms, generally distinguished by the long straight claw of the great toe. The only species which nest in this country are the skylark (*Alauda arvensis*) and woodlark (*Lullula arborea*).

There are many other families of perchers, arranged in three groups, but as none are represented in Britain mention of them will be omitted here, though allusion may be made to some of them in the sequel.

Order 2. Woodpecker-like Birds
(*Picariæ*)

Here are included a large number of short-legged birds, which mostly dwell in trees, and commonly make their nests in holes. As in perchers, the young are helpless nestlings.

Woodpeckers (*Picidæ*) [**264**], as represented by the most typical members of the family, possess climbing-feet, in which the fourth as well as the first toe is directed backward. The stiff tail-feathers also serve as a support. The powerful beak is well suited for breaking open rotten wood in search of insects and their larvæ, while the wormlike tongue is capable of an extraordinary degree of protrusion. Covered with glutinous saliva, it easily secures the prey, aided by its hard barbed tip. The commonest British species is the green woodpecker (*Gecinus viridis*).

The brilliantly coloured toucans (*Rhamphastidæ*) of South America are distinguished by the possession of an enormous beak, greatly flattened from side to side. In the wild state they are supposed to live chiefly on fruits and seeds.

Barbets and honey-guides (*Capitonidæ*). The former are somewhat clumsy birds of bright plumage, well represented in the tropics, but the chief interest of the family is centred in the honey-guides native to Africa, the Himalayas, the Malay peninsula, and Borneo. Some of the African species are asserted, on good authority, to lead the way to bees' nests, their share of the plunder being apparently the grubs in the combs.

Passing over the brilliantly coloured trogons (*Trogonidæ*) of tropical regions and the actively climbing little mouse-birds, or colies (*Coliidæ*), of South Africa, we come to the American family of humming birds (*Trochilidæ*) [**266**], which, though mostly found in the tropical parts of the New World, range from Tierra del Fuego to Sitka. Their wonderfully coloured metallic plumage almost defies description, and their wings can be moved up and down so rapidly as to be almost invisible, producing at the same time the humming sound from which the popular name has been derived. Like the African sun-birds, they render service to a number of bright-blossomed plants by transferring pollen.

The swifts (*Cypselidæ*), represented in Britain by one species only (*Cypselus apus*), if rare stragglers are ignored, closely resemble swallows in appearance and habits, but differ from them in many constructional features.

The goatsuckers, or nightjars (*Caprimulgidæ*), share with bats the work of hawking for insects after sunset. Some species, however, feed during the day. Our harmless nightjar (*Caprimulgus europæus*), though much maligned, is a most useful bird, which wages war on many insect pests. It is greatly aided in this pursuit by an unusually wide mouth, fringed with bristles. A well-known foreign species is the whip-poor-will (*Antrostomus vociferus*) of America, while the more-pork bird (*Podargus cuvieri*) of Tasmania belongs to a closely related family.

The best known members of the hoopoe family (*Upupidæ*) are distinguished by the possession of a beautiful crest on the head, well seen in the common species *Upupa epops* [**268**], which ranges from Britain (where it is an occasional visitor) to Japan.

The hornbills (*Bucerotidæ*) of Africa, India, and the Australian region are remarkable for their enormous beaks, upon the upper side of which is often a large projection known as a "casque" or helmet.

The bee-eaters (*Meropidæ*) are brilliantly coloured birds, with slender, curved beaks, found in most parts of the Old World. One species (*Merops apiaster*) occasionally wanders to our southern shores. The same bird is well-known and dreaded by bee-masters in Spain.

Kingfishers (*Alcedinidæ*) are nearly all natives of the Old World, possessing long, powerful beaks, and, for the most part, brilliant plumage. The third and fourth toes of their comparatively feeble feet are largely united together. This peculiarity probably assists our native species (*Alcedo ispida*) [**267**] to maintain its hold easily on some branch near a stream while it patiently awaits the appearance of the fishes upon which it preys.

Cuckoos (*Cuculidæ*) are widely distributed through both hemispheres, but only the Old World species, and not all of those, trade on the parental affection of other birds. The feet resemble those of woodpeckers. Our native cuckoo (*Cuculus canorus*) is not unlike a hawk in appearance, and the familiar love-call, which is uttered by the male bird only, is not a general characteristic of the family.

Order 3. Owls

(*Striges*)

There is only one family (*Strigidæ*), including familiar nocturnal birds of prey, with soft plumage, large eyes, and hooked beaks. Their general appearance is too well known to need detailed description, but it may be mentioned that the fourth toe can be turned either forwards or backwards at will. The young are helpless. Owls are found all over the world, and the most notable British species is, perhaps, the barn-owl (*Strix flammea*).

Order 4. Parrots

(*Psittaci*)

Here, again, we have but a single family (*Psittacidæ*), with some members of which everyone is acquainted. Climbing feet are present, with well-curved claws, but the most remarkable feature is the prominent hooked beak, the upper part of which is movable, being united by a hinge-joint to the skull. This increases its efficiency for both feeding and climbing purposes. The young are naked and helpless.

Parrots are most strongly represented in the Australian region and South-east Asia, after which comes South America. Africa and South Asia are pretty well off in the number of species, but only one is to be found in North America.

The curious nocturnal kakapo, or ground parrot, of New Zealand (*Stringops*), has almost lost the power of flight, and radiating feathers round the eyes give it an owl-like appearance. The pretty little grass-parakeets, or budgerigars (*Melopsittacus*), are natives of Australia, while the name "love-bird" is given to some small African (*Agapornis*) and South American (*Psittacula*) forms. Well known are the African grey parrot (*Psittacus erithacus*), notable for its imitative powers, and the gaudy American macaws (*Ara*, etc.) [**265**]. The crested cockatoos (*Cacatuinæ*) are only to be found in the Australian region, and north from this to the Philippine Islands.

Order 5. Pigeons

(*Columbæ*)

These are plumply built birds, with nostrils situated within a bare patch of swollen skin (*cere*) at the base of the beak, which is well developed, and mostly suited to vegetable food, for the temporary accommodation of which the gullet is swollen into a large crop. Only the first toe is turned back, and the feet are suited both for perching on trees, which are the usual home, and progression on the ground. The young are naked and helpless.

Pigeons and doves (*Columbidæ*) are very widely distributed, and of the four British species the rock-dove (*Columba livia*) is most interesting, as representing the ancestral stock from which all the domesticated breeds of pigeon have arisen by artificial selection. The large crowned pigeon (*Goura coronata*) and allied species, native to New Guinea and the adjacent islands, are perhaps the most striking forms.

A related family (*Dididæ*) includes three clumsy, flightless forms, all of them extinct—*i.e.*, the dodo (*Didus ineptus*) of Mauritius, a related

species (*D. borbonicus*) in Bourbon, and the solitaire (*Pezophaps solitarius*), formerly a native of Rodriguez.

Order 6. Gulls and Auks
(*Lariformes*)

The gulls (*Laridæ*) are very widely distributed sea-birds, of which the staple diet consists of fish and other marine animals, though at times they may migrate inland for feeding purposes, as well as for breeding. The feet are webbed, and the great toe is small. The young are fairly helpless. Our commonest native species are the common gull (*Larus canus*), the herring-gull (*L. argentatus*), and the black-headed gull (*L. ridibundus*). The terns, or sea-swallows, are related forms, with pointed tails and wings, and the common tern (*Sterna fluviatilis*) is abundant on the British coasts.

The chief British representatives of the auks (*Alcidæ*), which resemble gulls in structure and habits, are the razorbill, the guillemot, and the curious puffin or sea-parrot (*Fratercula arctica*). The flightless great auk or gare fowl (*Alca impennis*) formerly abounded in the neighbourhood of Iceland and Newfoundland, but has been extinct since 1844.

Order 7. Plovers
(*Limicolæ*)

The birds of this order are cosmopolitan, and are distinguished by the slender, often elongated, beak, while many of them are long-legged waders. The feet are not webbed. The young are covered with down when hatched, and soon learn to look after themselves.

Of well-known British species belonging to the chief family (*Charadridæ*) the following may be mentioned: Golden plover (*Charadrius pluvialis*), ringed plover (*Æjialitis hiaticula*), curlew (*Numenius arquata*), lapwing or peewit (*Vanellus cristatus*), common sandpiper (*Totanus hypoleucus*), woodcock (*Scolopax rusticola*), and common snipe (*Gallinago cœlestis*).

Order 8. Rails
(*Grallæ*)

These are somewhat primitive forms, in which the laterally flattened body facilitates progress through grass and thick undergrowth. Many of them have lost the power of flight. The young are covered with down when hatched and able to run about at once.

The best known British species included in the single family (*Rallidæ*) is the landrail, or corncrake (*Crex pratensis*), while of aquatic forms we have the water-rail (*Rallus aquaticus*), moorhen (*Gallinula chloropus*), and coot (*Fulica atra*).

Order 9. Bustards and Cranes
(*Alectorides*)

These are long-legged birds, the young of which are well developed when hatched, as in the last order.

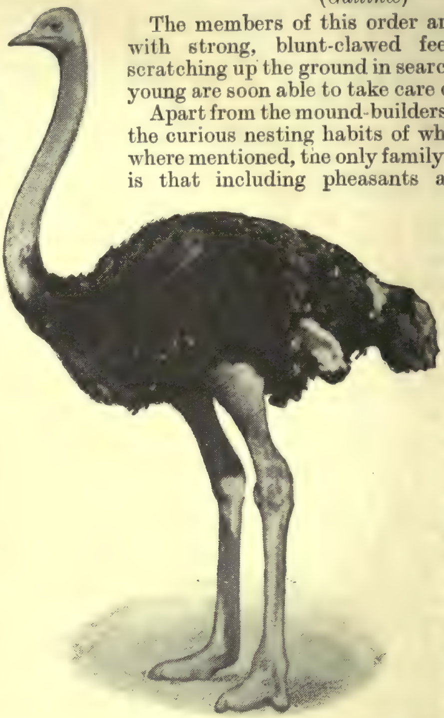
Bustards (*Otididæ*) are Old World forms which mostly live on plains. The great bustard (*Otis tarda*) was once a native of Britain.

The graceful cranes (*Gruidæ*) are widely distributed waders, of which one species, the common crane (*Grus communis*), was a native of East England till the end of the sixteenth century, but is now only a rare visitor.

Order 10. Game Birds
(*Gallinæ*)

The members of this order are ground birds, with strong, blunt-clawed feet adapted for scratching up the ground in search of food. Their young are soon able to take care of themselves.

Apart from the mound-builders (*Megapodiidæ*), the curious nesting habits of which will be elsewhere mentioned, the only family requiring notice is that including pheasants and their allies (*Phasianidæ*), some of which are to be found native in most parts of the world. Several familiar domesticated birds belong here—*e.g.*, guinea-fowl, which have been derived from a West African species (*Numida meleagris*); and turkeys originate from a North American form (*Meleagris gallopavo*). The red jungle-fowl (*Gallus bankiva*) of South Asia are ancestral to domesticated fowls, and the peacock (*Pavo cristatus*) [269] was originally native to the same part of the world.



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274. AFRICAN OSTRICH

The following game birds and ornamental forms also belong to the pheasant family: Argus pheasant (*Argusianus argus*), golden pheasant (*Chrysolophus pictus*) [272], common pheasant (*Phasianus colchicus*), common quail (*Coturnix communis*), partridge (*Perdix cinerea*), capercailzie (*Tetrao urogallus*), black grouse (*Lyrurus tetrix*), red grouse (*Lagopus scoticus*)—the only undoubted species of bird restricted to Britain—and the ptarmigan (*Lagopus mutus*).

Order 11. Eagles and Vultures
(*Falconiformes*)

The predaceous character of the members of this order is clearly indicated by the strong hooked beak, and the powerful talons. The great

toe cannot be turned forwards at will as in owls. The young are helpless, and remain for an exceptionally long time in the nest. Members of this order are to be found all over the world.

As a type of the larger members of the falcon family (*Falconidæ*) the golden eagle (*Aquila chrysaëtus*) may be taken. This handsome bird, or some allied species, served as the emblem of Rome in older times, and contributes largely to the heraldry of modern Europe. It breeds in Scotland (here and there in Ireland also), and has a very wide range in the northern hemisphere. A number of smaller species belonging to the family are also British, and of these the kestrel, or wind-hover (*Falco tinnunculus*), and sparrow-hawk (*Accipiter nisus*) are familiar.

The bare-necked carrion-feeding vultures are divided into two families, of which one (*Cathartidæ*) includes the American forms, and the other (*Vulturidæ*) the Old World species. The gigantic condor (*Sarcorhampus gryphus*) of the Andes, with its 9-ft. spread of wing, is surpassed in size by no other existing flying bird, while the little Egyptian vulture (*Neophron percnopterus*) is one of the smallest members of the group.

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276. EMEU

Order 12. Ducks, Geese, and Flamingoes

(*Anseres*)

The species of this large and cosmopolitan order are web-footed, aquatic birds, mostly possessing a flattened bill. The young are able to run from the nest as soon as hatched.

Dando

277. KIWI

One extensive family (*Anatidæ*) includes ducks, geese, and swans. Our wild duck (*Anas boscha*), ancestral to the domestic form, is a typical representative of the first group. Of diving species the eider duck (*Somateria mollissima*) is one of our winter visitors, while teal (*Querquedula quetta*) and widgeon (*Mareca penelope*), both non-divers, are common objects of sport.

Dando

275. CASSOWARY

Of geese indigenous to Britain, the grey lag (*Anser cinereus*) is perhaps the best known, and the domestic form is probably descended from it. Swans are characterised by their long necks and shorter bills. The white swan (*Cygnus olor*) is common throughout Europe, and also ranges into Asia and North Africa. The black swan (*C. atratus*) of Australia and the black-necked swan (*C. nigricollis*) of South America are remarkable on account of their colour.

The long-legged flamingoes (*Phœnicopteridæ*) are transitional to the storks, and possess a large beak, of which the end is sharply bent down, while red is the prevailing colour of their plumage. The common flamingo (*Phœnicopterus roseus*), widely distributed through Europe, Asia, and Africa, is rose-coloured.

Order 13. Herons and Storks

(*Herodiones*)

The long-legged waders which make up this order are represented in all parts of the world. The beak is long, strong, and pointed, and the feet are never more than partially webbed. The young are helpless.

Herons (*Ardeidæ*) are chiefly represented in Britain by the grey heron (*Ardea cinerea*), to which the bittern (*Botaurus stellaris*), now only an irregular visitor, is allied.

Of storks (*Ciconiidæ*), the common white species (*Ciconia alba*), occasionally seen in the east of England in spring, is sufficiently abundant in Europe, from which it migrates in late summer to Africa. The bald-headed adjutants or Marabout storks, with huge beaks, are among the most amusing inhabitants of the Zoological Gardens. They are indigenous to Africa and India, and the bareness of the head is an adaptation to the carrion-feeding habit.

Order 14. Pelicans and Cormorants

(*Steganopodes*)

This order embraces short-legged aquatic forms, which chiefly feed upon fish. All four toes are connected by webs. The young are helpless.

The pelicans (*Pelicanidæ*) are comical-looking birds with a very large beak, on the under side of which is a large pouch for the temporary reception of food. The common white pelican (*Pelecanus onocrotalus*) is native to South-east Europe and parts of Africa.

Cormorants (*Phalacrocoracidæ*) are among the most industrious fishermen of the sea-coast. We have two native species, the large black cormorant (*Phalacrocorax carbo*), and the small green cormorant or shag (*P. graculus*).

The gannets (*Sulidæ*) are represented in Britain by the common gannet or solan goose (*Sula bassana*), of which a noted breeding place is the Bass Rock in the Firth of Forth.

Order 15. Petrels and Albatrosses

(*Tubinares*)

The strong, somewhat hooked beak of the birds included in this order is well adapted for fish-eating, the feet are webbed, but the great toe is reduced or absent. The nostrils are placed at the ends of short tubes. Many of the species frequent the open sea. The young are helpless.

There is but one family (*Procelariidæ*), of which the following members may be noticed: The storm petrel (*Procellaria pelagica*), known to sailors by the name of "Mother Carey's chicken," and the object of much superstition, and the wandering albatross (*Diomedea exulans*) with an enormous spread of wing

Order 16. Divers and Grebes

(*Pygopodes*)

This is another group of thoroughly aquatic birds, well adapted to the pursuit of fish. The strong sharp beak is flattened from side to side, the legs are set on very far back, and the feet are much as in the last order, except that in the grebes they are not webbed, but the toes are fringed with flaps of skin. The young are helpless.

Our commonest native species of the sharp-beaked divers (*Colymbidæ*) are the great northern diver (*Colymbus glacialis*) and the red-throated diver (*C. septentrionalis*).

Two of the grebes (*Podicipedidæ*) haunt our inland waters, the great crested grebe (*Podicipes cristatus*), and the little grebe or dabchick (*P. fluviatilis*).

Order 17. Penguins

(*Impennes*)

These curious inhabitants of the southern hemisphere are all placed in one family (*Spheniscidæ*), of which the members are better adapted to an aquatic life than any other birds. The wings are useless for purposes of flight, but are converted into efficient paddles. All the toes are connected by webs except the small first one, and the legs are set on exceedingly far back, which renders the gait on land extremely peculiar. The sharp beak is straight, and the young are helpless when hatched out.

Toothed Birds. A small order of extinct birds is represented by toothed forms (*Ichthyornis*), of no great size, which lived during the chalk period in the western hemisphere, and probably resembled gulls in their habits. The members of another extinct order belonging to the same period also possessed teeth, and some of them (*Hesperornis*) were three feet or more in height. They were flightless birds, presenting marked resemblances to the divers, but were, perhaps, still more closely allied to the running birds, which we must now proceed to consider.

Running Birds. The running birds, characteristic of the southern hemisphere, have lost the power of flight, in accordance with which the breast-bone has no projecting keel. They have specialised for swift progression on the land, and the feathers are loose in texture. The young are able to run about as soon as hatched.

One family (*Struthionidæ*) includes only the African ostrich (*Struthio camelus*), the largest existing bird, being as much as 8ft. high **[274]**. Only the third and fourth toes are present, the former being much the larger. Both are padded below, like the extremities of camels, and for the same reason.

South American ostriches (*Rheidæ*) are smaller forms, possessing three toes. The same number of digits are present in the cassowaries (*Casuariidæ*) **[275]** of North Australia, New Guinea and the adjacent islands. The black plumage is hair-like, and the neck is more or less bare, and generally wattled, these parts being brightly coloured. There is a bony outgrowth, or "helmet," on the top of the head.

The three-toed emeus (*Dromæidæ*) **[276]** are not unlike cassowaries, though somewhat larger, but possess neither the brightly coloured bare patches and outgrowths in the neck region, nor the "helmet" of the latter. The beak is flattened from above downwards.

The kiwi (*Apteryx*) **[277]** of New Zealand represents still another family (*Apterygidæ*), and is the only living running bird possessing all four toes. It is about the size of a large fowl, and its long narrow beak is used in probing the ground for earthworms. In many points of structure—*e.g.*, the number of toes—the kiwi resembles the moas (*Dinornithidæ*) of New Zealand, all of which have been extinct for three hundred years or more. The largest of these (*Dinornis maximus*) stood about 12 ft. high, while the smallest (*Anomalopteryx parva*) was no larger than a turkey.

Record Eggs. Until some two hundred years ago, huge four-toed running birds (*Æpyornithidæ*) existed in Madagascar, the largest of which was about 7 feet high. These were probably the original of the fabulous "roc," spoken of long since by Marco Polo in recounting his eastern travels, and often mentioned in the "Arabian Nights." They surpass all other known birds in the size of their eggs, some of which measure no less than 13 in. long by 9½ in. broad, with a capacity of about two gallons.

The oldest kind of extinct bird (*Archæopteryx*) is represented by two species about the size of a rook, which lived in what is now the European area, about the middle of the secondary epoch [see GEOLOGY]. The structure is in many ways less specialised than that of existing forms, and affinity with reptiles is indicated not only by the presence of teeth, but also by the possession of a long lizard-like tail which, however, supported about 20 pairs of quill feathers.

Continued

Continued from page 2096

DAIRYMEN

Since the days when milk was produced in dirty town cowsheds, carried in open pails on a pair of yokes by buxom, short-skirted women and gaitered men, and delivered in a generally impure condition, there have been great changes. Our knowledge of the influence of germ-life on a very perishable fluid has enabled us to take precautions to ensure purity and cleanliness and to save losses of life and money which were in those days deemed impossible.

Precautions for Purity. The milk now consumed by our large populations is produced almost entirely in the country, while every farm, if not actually inspected, is required by law to be under systematic inspection. Milk must be pure, clean, cooled by refrigeration to a low temperature, and contain at least three per cent. of fat, while persons suffering from any form of contagious or infectious disease must not handle it, the cows which produce it, or the utensils in which it is carried. These precautions demand considerable knowledge on the part of the milk vendor. Notwithstanding the law, however, adulteration is still common, skimmed or separated milk—*i.e.*, milk from which the cream has been removed by hand or by machine—being employed for the purpose instead of water, while pure milk is often badly cooled, badly strained, and delivered in so dirty and imperfect a condition that a sediment often appears at the bottom of a vessel into which it is poured. The result is that epidemics of disease occasionally occur, that the germs of tuberculosis, or consumption, are frequently discovered by scientific examination, and that large quantities of milk are spoiled during the hot weather.

The Milk Vending Business. Milk is sold by other traders than the dairyman, with the result that its quality and character are more frequently impaired. It is retailed by itinerant vendors, by the occupiers of chandlers' shops, by confectioners, fruiterers, and general dealers. We have, however, in these pages, to deal with the dairyman, whose business should be to obtain his supplies direct from the producer, or, it may be, as in the case of very small concerns, from large wholesale merchants.

A milk business is either purchased or established. To establish a new business is extremely difficult in a district which is already well supplied; but our population is growing, and in all large cities, as houses are built shops are opened, and the prospective dairyman obtains his chance. Similarly, in many small country towns badly supplied by small cowkeepers, there are openings for well conducted, attractive shops at the hands of men of energy, knowledge, and experience. In starting an entirely new business, the dairyman must take great pains to select his locality and to estimate with care the probable increase in the population, the existing competition, the cost of labour, rent, rates and taxes, the contiguity of the railway-station, and the class of customer to whom he would look for support. His aim should be not only to obtain clients who consume large quantities of milk but who are willing to pay the best price for it. This work involves considerable labour, enterprise, and patience, and he may, therefore, find that, after all, if his capital is sufficient, it would pay him better to purchase an existing and successful concern. To this end he should both advertise and reply to advertisements, and, in addition, make his requirements known to one of those agents who negotiate businesses of this character.

Scrutiny before Purchase. Having met with something which he believes may suit him, he will make the most careful investigation as to the quantity of milk and other produce sold, its prime cost, and what it realises by retail. He will examine the books, and take care to verify their accuracy; he will go the rounds with the milk deliverers, and ascertain precisely what is sold and how far he may trust the honesty and soundness of the customers. In many populous districts the people are constantly moving, and leaving their milk bills unpaid, but in justice to himself he will leave no stone unturned to satisfy himself before he pays a shilling for what might possibly be a more or less bogus concern. The milk trade offers many opportunities for fraud, and of this fact many avail themselves. The man, therefore, who will adulterate milk and cream, sell imported butter and eggs as fresh home produce, or infants' milk in sealed cans, drawn from special cows which he does not possess, is not likely to display any particular sense of honour in dealing with a proposed purchaser of his business.

The Shop. A dairyman's shop should be equipped with two objects, first, to attract customers by its generally smart and cleanly appearance, and, secondly, to minimise any possible influence upon the keeping qualities and flavour of the goods. As in the apartments in the back

premises, the floors, walls, ceilings, counters, and fittings should be constructed of such materials as will reduce the collection of dirt to the smallest possible quantity. The floors should be tiled, the tiles non-absorbent and laid in cement; the counters marble, the shelving of marble or slate; the walls hard and smooth, either tiled or of parian cement; and the various fittings as far as possible of glazed earthenware.

To Prevent Contamination. The atmosphere, even of a town suburb, is crowded with an incalculable number of particles of dust and bacteria; hence, as far as possible, all perishable goods, and especially milk, cream, and butter, should be under cover. The milk in the vessel on the counter should never be exposed; nor should butter, as is common in almost all provision dealers' shops, be exhibited in large blocks just as it is turned from the cask or the case. Butter should be on sale in rolls, preferably marked with a special brand, already made up, and, except such as are reserved in a glass showcase, ready packed in grease-proof paper and dainty boxes. Window or counter ornaments and plants are attractive, and add to the general appearance of a well-arranged retail shop. Hints, however, may be obtained by examining some smartly equipped premises, such as those of Messrs. Welford and the Express Dairy Company, in London, Hailwood's in Manchester, and Frowde's in Brighton.

The Back Premises. The back premises, in which the milk and other produce are handled in bulk, should be as carefully equipped and as clean as the shop itself; and customers should be systematically invited to inspect them, for confidence is in this way easily imparted. There should be a milk-cooling tank, a milk refrigerator, a separator for removing the cream from unsold milk, a churn, a butter-worker, and other similar appliances necessary for converting this cream into butter; an apparatus for sterilising the various utensils and vessels employed, a cold room or safe for cream and butter—indeed, for milk also, if the expense can be borne—a steam jet, and hot and cold water with hose for cleansing floors, churns, and other appliances. The premises should be carefully ventilated, and the drains carried outside, and carefully trapped. There should also be a well-paved covered outside shed for receiving and dispatching the milk in perambulators and carts—if these are used—and cleansing the larger portions of the plant.

Contracting for Milk Supply. Where the quantity daily sold warrants the practice, the milk should be purchased direct from the farmer under contract. Contracts in the milk trade usually provide for two prices, from April 1st to September 30th, and from October 1st to March 31st, or thereabouts. The buyer will stipulate to purchase on the London system—per barn gallon of 17 pints, by the imperial gallon, or by the dozen quarts, as the case may be. He should require the milk to contain at least 3·4 per cent. of fat, sampling it regularly and obtaining periodical analyses. So long as it covers the standard, he will not be too exacting with the vendor if its average is satisfactory. While, however, not always insisting on these figures, he should look for at least 3·5 per cent. of fat, which every farmer can supply if he chooses to take the trouble to select his cattle. The following is a sample form of agreement used by one of the largest and best London retailers:

AGREEMENT made this between (hereinafter called the vendor), of the one part, and (hereinafter called the purchasers), of the other part.

For the considerations herein expressed, it is mutually agreed between the parties thereto as follows—namely:

The vendor agrees to sell, and the purchasers agree to buy, from to pure, sweet, and merchantable cows' milk in quantities of to lots daily in the months between Lady Day and Michaelmas, and to lots daily in the months between Michaelmas and Lady Day.

Each lot to consist of imperial pints, and the price per lot to be

The vendor to pay all railway charges, and deliver the milk free to the purchasers at the railway station of the Railway twice daily at o'clock in the morning, and at o'clock in the evening. The account of the milk delivered to each Saturday night to be forwarded to the purchasers not later than the following Tuesday morning.

The vendor further agrees with the purchasers that he will in all respects conform to all the conditions and stipulations mentioned in the Schedule hereto, and abide thereby in every respect, and such conditions and stipulations shall form part of this agreement.

The schedule deals with the quality and purity of the milk, cooling, straining, cleaning vessels, condition of cows, sickness, churns and cans, inspection, and other necessary details.

Relations with the Farmer. It is important to see that the daily supplies of milk arrive from the producer in clean cans or churns. If either be unclean, or if the milk be coloured, mixed with preservative drugs, or tainted, it should be returned at once, and an explanatory telegram sent. The farmer should not be beaten down in price; he must be paid well for a first-class article—feeding, cooling, straining, and cleaning all involving extra labour. The milk should be paid for with unerring regularity—farmers generally prefer weekly payments—and it should be delivered punctually to customers. The carriers should be supplied with measured quantities of milk for their rounds, and never expected to deliver more than they take. Samples should be taken from each deliverer's churn before it is locked. In no case should they be allowed to deliver milk except from the taps of their churns. The milk carrier should be paid well, and receive extra payment for every new customer he obtains. He should be required to give good measure. It may be found that in some instances short measure is given, and that in consequence milk is sold for cash which is not accounted for.

AN ARTISTIC INTERIOR: ONE OF MESSRS. WELFORD'S DAIRY SHOPS

Cream and Chemicals. Customers should be supplied with cards explaining the conditions necessary for keeping milk and cream sweet, and the food value of each article. The sale of cream should be fostered with energy; it may be sold with profit at two-thirds its present retail price, and a reduction on this basis might be expected to largely increase the demand. The cream trade will bear great expansion. Chemicals or drugs should never be employed to preserve either milk or cream; customers are learning to regard both with suspicion, and many leave vendors who use them. Although it is not a common practice in the trade, the retailer who would conduct a high-class business will be well advised to stick to British and Irish butter [see Buttermen in this course], to make a speciality of a well-selected English make for sale to the wealthy, and to brand every roll. A business man supplying well-to-do customers should avoid margarine.

Milk should never be coloured; although the practice is common, it is dishonourable. Rich milk producing plenty of thick, yellow cream should be the leading article; it will recommend itself and secure many customers. One of the oldest and most prominent firms in London find it possible to sell milk which is neither coloured nor preserved all the year round and yet the trade in general insist on both practices.

Precautions with Employees. If an employé or any member of his family is attacked with a contagious or infectious disease the employé should be kept off the employer's premises at the discretion of a medical man, and paid all or part of his wages; this should be a matter of agreement on engagement. Every employé should be required to report any case of illness in his home. Servants handling milk should wash before starting on a round for its delivery. Each man should be provided with a clean smock coat or jacket weekly, or more often if required. The milk vessels supplied to each carrier should be examined before he receives the milk for his round. The milk can or churn should be locked up before starting, the quantity of milk supplied being recorded as well as that remaining on return from the round. A veterinary inspector should be employed to make an occasional report as to the health of the cows and the conditions of the premises of the farmers supplying the milk. He should also be asked, where a medical man is not engaged for the purpose, to inquire and report upon the health of the families of the farmer and his employees.

Sterilised Milk. Customers should be encouraged to purchase bottled sterilised milk, which can be supplied at small expense. This milk may be delivered in weekly lots. Thus, instead of calling upon the customer twice daily, one weekly call becomes sufficient. If customers object, they may be induced to accept bottled milk for their Sunday supply, thus reducing Sunday labour, which is an objectionable feature of the dairyman's trade.

The following is a sample form which should be filled up by farmers from whom it is proposed to purchase milk.

PROPOSAL TO SUPPLY MILK.

Name and address in full........................
Telegraph office and station........................
Time milk will arrive at station of destination.......
Number of cows kept in milk and if any tuberculous
....
Daily quantities for sale........................
To whom previously sent ?........................
Is your farm generally in a good sanitary condition ?
....
Has it been medically inspected, if so, by whom, and at what date ?........................
Source of water supply :
For domestic use........................
For cooling........................
For washing utensils........................
For cattle drinking........................
Is there any sickness of a contagious nature on your farm or in the neighbourhood ?........................
Price asked per imperial gallon delivered at our station ....

The milk retailer should carefully study the laws governing the supply of milk and other dairy produce. These include the Sale of Milk Regulations (1901), the Sale of Butter Regulations (1902), Sale of Food and Drugs Act (38 and 39 Vic. ch. 63), Sale of Food and Drugs Amendment Act (1875), Sale of Food and Drugs Act (1899), Margarine Act (1887), Dairies, Cowsheds, and Milkshops Order (1885).

DOMESTIC ENGINEERS

By a process of evolution there is growing up in our large towns a class of traders which has not yet been generally recognised by the public. For the want of a better name that of *domestic engineer* has been given to the class, but the term is something of a misnomer, because the word engineer presupposes one who designs or manufactures something of iron, steel, or metal. These tradesmen are not strictly retailers. They make small pretence to window displays and show-room stocks, though some lines, chiefly of the nature of materials, have to be carried. The business of this class of tradesmen is to erect and maintain in repair the various fittings which go to complete the equipment of modern houses. The trade is at present split up into a number of well-defined sections, but there are evidences that it will become concentrated under single management in the course of a few years. An up-to-date review of the many departments of shopkeeping generally would not be complete without some reference to the possible development of this business from the commercial standpoint, and elsewhere the SELF-EDUCATOR will deal with the technical sides of this opening for a career.

The Engineer in the House. When one looks round a house it is discovered that four distinct classes of mechanics besides the builders have had a hand in the work. These are the plumbers, the hot-water fitters, the electricians, and the gasfitters. To the first falls the cold-water service, certain parts of the roofing, the flashing round the sinks, the fixing of the bath, lavatory basins and closets. The hot-water supply is executed by the pipefitter—sometimes the plumber does this—who also fixes the range in conjunction with the builder's men. The electrician, or wireman, puts in the bells and the electric light, and, finally, if there be a gas cooker, gas fires, or incandescent gas lamps, the gasfitter takes a turn. At present these trades overlap more or less, and so far as the plumbers are concerned there is some anxiety to secure the lot exclusively—a game of grab to which the hot-water fitters do not feel inclined to agree; but from the contention—for there is contention—a new class of tradesmen, who will qualify themselves to undertake the whole of the work, will be evolved. These will employ plumbers, pipefitters, and wiremen, and by concentrating work under one management, expenses will be kept down, and efficiency secured.

Possible Developments. Under the conditions indicated, the business of domestic engineering ought to develop large possibilities. Fifteen years ago a £30 house with a bath and hot water supply was the exception. To-day houses in the London suburbs letting as low as £26 have to be so fitted. To-day not one house in a hundred in even good residential districts has its independent hot water warming installation. In fifteen years' time these will be the rule, and more than likely a small electric motor and electric cooking appliances will also be common.

Particularly are there splendid opportunities of developing the business in heating by hot water apparatus. Within the past few years the cost of radiators and boilers has been greatly reduced, and their efficiency improved. The public are gradually coming to recognise that coal fires are wasteful. The objection against the radiators on the score of appearance has been removed by artistic patterns and good moulding, and so much has been printed about smoke abatement and fog in the press of recent years that the silly sentiment about seeing a cheery fire no longer carries its former weight.

Equipment for the Work. The capital required to start in business as a domestic engineer would be about £350. Of this about £200 to £250 will be sunk in plant, which would include a small gas engine, or an electric motor of equivalent power, and a few small machine tools, such as a drilling machine, lathe, lawn mower, grinder, screwing machine, polishing wheel, lacquering table, besides the usual portable tools associated with the plumbing, gas-fitting, and electric wiring trades. The balance of the money would meet the working requirements of the business, including some stock, but obviously the material required for most of the contracts would require to be ordered as it is wanted, and consequently not a large sum would be invested in this direction. The prospects of success are considerable, and the technics of the business not particularly difficult to acquire, provided the tradesman has a practical knowledge of at least one of the departments.

On the whole, the plumber seems to have the best chance of making the business a success, not because he is ordinarily the best craftsman

of his class, but on account of the standing given to the craft by the system of registration which obtains in the trade. It is a moot point whether registration affords the public the extra security against scamped work which is claimed by its advocates. The fact remains that the plumber, by common consent, seems to rank high among the other trades indicated in spite of gibe and jest in the popular papers. For one thing, he is usually a handy workman, able to use a variety of tools besides those peculiar to his own craft, although in these days of trades unions, he is not always willing to do so. Here, however, we are dealing not with the prejudiced trade unionist, but with the man who is anxious to drop the mechanic's overall for the more profitable garb of master man and employer of other men's labour.

The Necessary Technics. How can an aspirant for a wider sphere of operations qualify himself? We put the matter to the younger men, for they can use the opportunity to the best advantage. The first thing to do is to throw to the winds all the nonsense about poaching on other trades. No job must be refused if by trying it the mechanic can add to his experience. Besides, a certain amount of study will be necessary for the domestic engineer. His customers will expect him to have a fair amount of technical knowledge on such matters as sanitation, light, heat, ventilation and electricity. By a happy coincidence the men to whom we are addressing ourselves have in their hands much of the information that will assist them to proficiency, for the scheme of the SELF EDUCATOR covers all the subjects as well as such others as geometry, draughtsmanship, building construction, commercial arithmetic, and book-keeping. In a word, the man with a craft at his fingers' ends and enough brains in his head to understand the elements of science, stands a far better chance of succeeding in this business than another without these qualifications, although the latter might have a big bank balance to his credit.

Stock. It is hardly necessary to catalogue the stock that would be requred to be held by a tradesman in business as a domestic engineer. A section has already been devoted to builders' merchants, others are in preparation dealing with ironmongery and other branches of trade which cover the stock to be carried. Briefly, the stock must include such goods as gas tube and fittings, lead and lead pipe, compo pipe, some sanitary goods in salt glazed, cane, and white ware, electric wire and fittings, possibly a few bells and batteries, electric lamps, gas mantles, some glass such as shades and chimneys, etc. For the rest, the domestic engineer need only to know where to buy what he wants, and to have proper relations with his wholesale firms and manufacturers, who nowadays are expected to send orders from stock at very short notice.

The profits have yet to be determined, but in a given turnover it would be a safe estimate that half represented material sold, and the remainder labour charges. The former ought to average a profit of 20 per cent. gross on the cost price, the latter probably rather less; but much would depend upon the locality in which operations were carried on. Business among builders, for example, would be cut finer than work done for substantial householders. The whole matter is in a somewhat nebulous stage at present, the work being spread over many trades; but sooner or later it will be systematised, and those that are ready with a theoretical knowledge of the trades different from the one they practise will be the men to catch the plums which are nearly ready to fall.

DRAPERS

The Evolution of the Draper. In the ages that are past the draper was a man who sold cloth; to-day he is a merchant who deals in a heterogeneous assortment of goods, with drapery as an unobtrusive side line. For drapery, properly so-called, means cloth and stuff goods, household and personal linen, white cotton piece-goods (or "longcloths"), cottons and calicoes, Irish linen, tablecloths, serviettes, blankets, towelling, prints, flannel, etc. All these things, of course, are necessaries of the trade of a draper still, but the present-day retailer finds that there are many other lucrative adjuncts to his business—more profitable and easier to handle and to stock—that the present generation of purchasers demands. It can be easily understood that, as this country grew richer and more "civilised," the desire for finery increased, and nowadays millinery (with flowery and feathery trimmings), stoles, hosiery, gloves, ribbons, laces, ladies' outfitting, corsets, blouses, mantles, and furs, are far more important sections of the business of a draper than the heavier goods of the Manchester market. Indeed, so general has become the business that there seems scarcely any goods of a "fancy" character which the modern draper of any pretensions does not find it profitable to handle. It is not our purpose, however, to go into the departmental store system into which "drapery" has drifted, but rather to confine ourselves to what the Americans call the "soft goods" trade.

Apprenticeship. The best experience is obtained in a provincial house. In large towns, London especially, an apprentice may serve his three or four years in one department only; probably two or three, if he be fortunate. But in the drapery "emporium" of a good market town in the provinces he has an insight into all departments. Moreover, in such a business he has to take his turn in the counting-house, where he learns, if he will, how to keep books, how and what to buy, how to mark prices, and, in short, he is taught the business principles necessary for his success as a business man. The advantages of such a training as compared with that of a youth who has spent his four years apprenticeship in the "ribbons" or the "laces" of a large metropolitan house are too obvious to dwell upon. The indoor system is still the rule in the drapery business, but in some country houses in England, and everywhere in Scotland, outdoor apprentices are taken at a small weekly

wage ranging from 6s. to 9s., as the period of apprenticeship lengthens and the youth becomes more useful.

Assistantship. Improvers who migrate from their training house to enlarge their experience generally get £20 or so per annum to start (in an indoor berth), and 9s. to £1 a week outdoors, the salary gradually increasing with the age, experience, and ability of the assistant to £50 or £100 indoors and a corresponding outdoor wage. In a large drapery house, it has been found that the average payment to the lowest female assistant was £47 per annum, and the average highest £105 per annum, plus board and lodging. The outdoor assistant generally gets dinner and tea in addition to a weekly wage. In most drapery houses nowadays commissions on sales and premiums on old stock goods (generally called "spiffs") are paid, the amount of commission varying according to the price of the articles sold, and it is quite a common thing in the larger houses for smart assistants to double their salaries by this means. It is surprising how this "spiff" system makes old goods new in the eyes of the assistant and how it enhances his, or her, selling capacity.

The aim of the embryo draper during assistantship should be to obtain as varied and diversified an experience as possible. He will probably have one pet department—laces, hosiery, or gloves, perchance—to which his tastes incline, and of that department he should know all that is to be known. But the other departments should by no means be neglected. "Know something of everything, and everything about something" is a motto which is as true in drapery as it is in other departments of life.

The New Start. All the huge businesses of to-day have had humble beginnings. It is said that the founder of the most famous drapery business in the country opened in a small shop with a capital of less than £200, while one of the best known business houses in the West End of London was started on £40. The opportunity and the man are the principal requisites of success in any sphere of work, and we will suppose that our man has gained as much experience as he reasonably can and that he has discovered what he considers to be his opportunity. We will imagine that the opportunity includes an ordinary shop with one large window in a likely neighbourhood and a sum of £300.

He should make it a point to choose a street in a neighbourhood where ladies especially promenade. He must see to it that he is on the right side of the street—that is, the side on which the greatest stream of promenaders pass. A cautious man will watch the shop he has in mind for a day or two before deciding, to make sure that there is a fair amount of traffic. The shop-fittings would not cost much. The prudent man will see that his painting and papering is carefully done, that the "shell of the shop," as it were, looks smart and inviting. Then all that is required is a long counter with a glass top and glass all round if possible, and ordinary shelving. Glass counters and shelving may often be bought secondhand for a very small sum. The whole should not cost more than £30, but it is advisable that the window fittings should be as natty as possible, especially if a trade in fancy articles is projected. And it is in fancy articles like hosiery, gloves, ribbons, lace, and things of everyday request, that the modern draper now begins business. Such things are easily and inexpensively stocked, they make a grand show, and they are quickly disposed of. The far-seeing man, by careful preliminary observation, may be able to gauge with fair accuracy the class of goods that will suit the neighbourhood. He should try to get a "special line," be it hosiery, gloves, or what not, well placed in the window to draw people into the shop.

Window and Wall Fittings. With regard to interior fittings, these necessarily vary according to the shape of the premises and the space at disposal. A very useful article to have is the double-sided dividing mirror shown in **1**. It is in a polished wood frame mounted upon two wheel castors, so that it may be easily moved. The object, of course, is to divide a window into sections so that one window may be dressed with two different classes of goods without one clashing with the other. We also illustrate [**2**] an ordinary wall fitting with a counter and plate glass top, admirably suited for a beginner.

This is from a design by Messrs. Samuel Haskins and Brothers, of London, and the chief point in this scheme is that it has over-counter display rods, which enable the goods to be shown with great effect. The rails are carried by suspenders which are fixed to the top of the fitting, which must be specially constructed with bearers to receive it. The cost of these rails and suspenders complete would be about 8s. per lineal foot in 12 feet lengths and upwards. A variation of this over-rail idea is the "Zigzag Railing," as it is called, which allows of the goods being shown at an angle. The "Zigzag" costs about 12s. 6d. per lineal foot, measured in a straight line from end to end. The wall fitting consists of openings to receive either boxes, drawers, or packages.

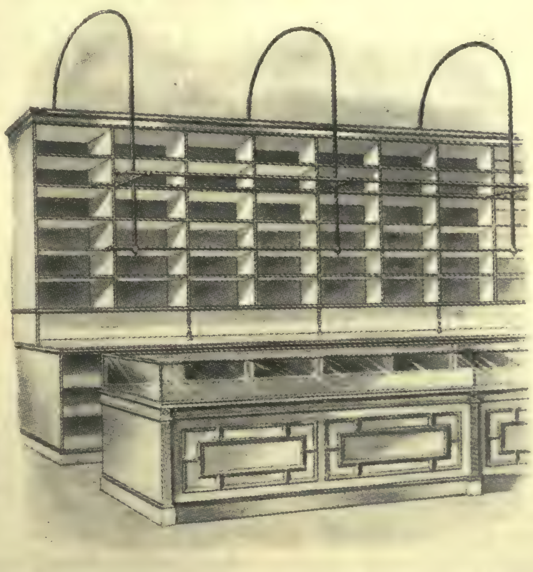
This class of fitting is made from 8 to 9 feet high, sometimes more, and the size of openings depends upon the class of goods or department it is used for. If, for instance, it be used for a ribbon stock, the openings should be about 18 inches across by 6 inches high, and fitted with glass-fronted drawers, so made that they are practically dust-tight. The goods in the drawers are kept undamaged and the glass-fronted drawers allow of a beautiful arrangement of colourings exposed to view. For such departments as laces, gloves, etc., the openings would be filled with cloth-covered boxes. The recess space is a feature of this class of fitting, dividing as it does the lower from the upper part of fitting, and also enabling one to form the lower part deeper than the upper part. When the recess is lined with mirror it affords a splendid opportunity to display goods.

Expense of Fittings. The cost of such a desirable fitting varies considerably with the size of the openings, but the price of a fitting similar to that shown would be about 35s. per lineal foot, without boxes or drawers. Glass-fronted drawers would be about 8s. 6d. each, and boxes from 3s. 6d. upwards, according to size and quality. The counter and case shown in front of the fitting are of a useful type. The lower part is formed with a tracery moulding and panelled front, pilasters, and plinth. The interior of this class of counter is usually fitted with a potboard, shelf and divisions forming a certain number of openings. In some counters the interior may be fitted with drawers, such as for haberdashery departments. The case over the counter should be made with ebony or black wood bars, and the whole glazed with polished plate glass. The flaps at the back of the case are hinged and fitted with spring catches and lined with mirror. Sometimes the bottom of the case is lined with mirrored glass, but in many cases in cloth, or with loose trays. The cost of such a counter would be about 30s. per lineal foot in 10 feet lengths and upwards, and the same for the case.

1. A VALUABLE MIRROR DEVICE FOR A DRAPERY WINDOW

A corner of one of the show-rooms in the trimmings and haberdashery department of Peter Robinson, Ltd., of Oxford Street, London, is shown in 3. It speaks for itself, and is a fine sample of interior display.

Establishing his Credit. A young man with £300 and a good record will have little difficulty in obtaining stock. The usual plan is for him to place his credentials before one of the large wholesale houses of good standing and, if accepted, to make that his "reference house." He then goes round to the wholesale dealers in silks, laces, blouses, outfitting, and so forth, tells each that he is starting in business, gives his orders, and refers them to the standard house. By this means he gets the supplies he needs and varying periods of credit. Here the much-abused system of "dating" comes in. If he buys on February 1st he can usually arrange to get immediate delivery, but the goods may be dated May 1st, and payment is not demanded until a month after that. The wise buyer will take advantage of full discounts for payment within the specified period, 2½ per cent. to 3 per cent. being the usual discount for a month. The advantage of such an arrangement to a smart man is obvious. It gives the energetic man an opportunity to turn over the stock and order a new lot by the time his first payment is due. As it is necessary that a draper's stock should be turned over at least four times a year, it will be seen that it may be possible for an able man with fairly good luck to turn over his stock within the twelve months without touching his capital.



2 A CONVENIENT DRAPERY WALL AND COUNTER FITTING

Buying. Great caution is necessary in buying. "Goods well bought are half sold," is a truism no young draper—or old one for the matter of that—should forget. Every traveller's goods should be inspected, for one never knows when one may hit upon just the thing one wants at a trifle less than another has shown. These small savings amount to something in a year. Be sure to get the full discount on every account. This is money earned at very little trouble, and should be watched carefully. Prompt cash will scarcely be possible at first, but it will be easier month by month. In many large businesses it is said that the discounts pay the salaries and expenses of the counting-house.

Amount of Stock. Always keeping in view the careful man feeling his way with £30 already spent in fittings, we pass on to the amount of stock necessary in order to make a presentable display. From £25 to £30 worth of hosiery would be required for a start, while £10 worth of ribbons would be ample. Then a fine assortment of laces could be obtained for £25, while corsets would run into another £20. Haberdashery is an important and profitable branch to cultivate. This includes cotton, thread, needles, pins, and such things, and £50 would not be too much to spend on that department. Baby linen and servants' aprons pay well, so £10 would be laid

out on these, while £15 judiciously spent in a nice selection of blouses would produce a flattering return.

The foregoing computation applies more particularly to a start in the metropolis, or in some of the larger provincial cities and towns, where there are within easy reach large wholesale houses from which short stock can be quickly renewed. In a country town, a larger initial outlay would be necessary, but in all cases the methods pursued by the successful business men of to-day have invariably been to start with light stocks, and to keep buying little by little to fill up. The London man, with the finest wholesale houses in the world at hand, has many advantages over his country brother, but the provincial man has usually the benefit of less competition and better prices.

Specialising. As the tendency of the age is towards specialism, it is necessary that the young business man should take up some special line suitable to his neighbourhood, and push it. It is half the battle when the ladies of the neighbourhood are forced to recognise that for laces Jenkins is preeminent, or for baby clothes Hopkins cannot be beaten. The fame of a draper as a specialist by no means retards his development in other departments. His laces may be unrivalled, but he should see to it that the extra profit on laces should be used in making the dress stuff and other departments so complete that the lady who hankers for laces may also be induced to buy dresses.

The "ready-made" departments are popular —they are indicative of the feverish hurry of the present day. Blouses, skirts, jackets, and ladies' outfitting must be kept in all sizes and varieties ready for immediate use. The old fashion of buying goods by the yard and having them made up at home is almost dead. Sheets, pillow-cases, and towels must be ready-made, and in many cases, ready-washed. The up-to-date draper should also undertake to mark all household goods free of charge.

Ready-made Businesses. As a rule, it is better to start off one's own bat, so to speak, than to buy a going concern. This rule applies more particularly to businesses in a big town, for town people appear rather to prefer going to a new shop. The *blasé* inhabitants of large cities are ever on the look-out for new sensations, and a new adventure attracts them, more often than not, on account of its novelty. There are, of course, the usual exceptions which prove this rule. For instance, a man may buy for £200 a business which is dwindling from neglect, perhaps, or from want of enterprise on the part of the proprietor. Such a business may merely want new blood and brain to make its owner's fortune. There are many businesses of that type to be found advertised in the trade journals, and there are many other genuine businesses for sale in which the proprietors have made a fortune, but these are not to be purchased for £300. Therefore, the young man with limited capital and plenty of "go," if he contemplates starting in a large centre, usually passes over the businesses for sale.

The Provincial Business. In a country town, however, the exact converse holds good. There, local considerations make it necessary for a stranger, in order to get anything of a footing, to buy an old-established business. Country people are more conservative, less fickle in their tastes. They like to patronise the shop in the market place where their fathers, and maybe their grandfathers, have always bought. They like to look in on market days and order £10 or £20 worth of goods from people who have grown up in the town, and who know their idiosyncrasies. The "new start" has a rather quiet time of it for the first few years, until his standing, conduct, religious and political opinions have been accurately gauged, and he has broken down the cautious reserve of his neighbours.

When things are going all right, and the prospect of making a business seems certain, negotiations should be begun for taking a lease of the shop. Many a young man finds that when he has begun to build up a prosperous trade, the landlord considers it a favourable opportunity for increasing the rent. Such a contingency should be guarded against as early as possible in one's business career.

Profits. The average rate of profit in the drapery business is from 22½ to 25 per cent. It must not be forgotten that the stock should be turned over at least four times a year. Thus, a £300 stock turned over four times at a 25 per cent. profit, would leave a gross profit of £300 at the end of the year. Half, or more of that sum is required for rent, rates, etc., and working expenses, and the net profit would be probably £100 to £150. This is putting a rosy view on things, and excluding misfortunes, and we do not say that everyone will do that the first year, or even the second. But we are assuming that the adventurer knows his business, is careful, works hard, buys keenly, and takes full advantage of discounts. He would require to have at least two lady assistants—one costing probably £30 and the other £18 per annum and their keep—and one errand boy, who would receive, perhaps, 6s. a week. The profit made during the first few years should be put, of course, into the business. The stock in each department, or at least in the best paying departments, would be gradually increased. Improvements would be made in the shop-fitting. Glass cases may be added for the display of the finer class of goods, and in a year or two, perhaps, even a new shop-front may be put in, with a better window for displaying the tempting *lingerie* so dear to the feminine heart.

Profitable Departments. As has been already stated, it is the fancy goods on which the biggest profits are made. Millinery, ladies' underwear, hosiery, corsets, baby linen, blouses, jackets, and cheap furs, all command a quick turnover and good profit. On hats, a profit of at least 33⅓ per cent. is gained, and many of the shops in populous working-class districts nowadays use millinery more as

3. A CORNER IN THE DRAPERY ESTABLISHMENT OF PETER ROBINSON, LTD., OXFORD STREET, LONDON
Illustrating an approved manner of stocking and displaying goods

an advertisement than anything else. They advertise "Hats trimmed free of charge" as a draw, and in spite of the fact that they have to keep milliners to do the work, the profits are such on the bare material that it pays, not to speak of the custom it attracts. Mantles and jackets are also good articles for those who know how to handle them, and it is no uncommon thing for a smart man to turn over fourteen or fifteen patterns of jackets—costing, say, 14s. each, and selling at one guinea—eight or ten times during the year. Rabbit-skin furs that cost, perhaps, 2s. 9d., 3s. 11d., and 5s. each, sell like hot cakes at the first "nip of winter" at, say, 3s. 11d., 5s. 6d., and 7s. 6d. respectively. Costumes, coats and skirts, umbrellas, all bear good profits and sell quickly. The lowest profit is made on "Manchester goods"—true drapery. The average rate is from 17 to 20 per cent., and the stock is bulky, heavy, and slow of sale, but it must not be forgotten that in this there is little or no bad stock.

Credit. Except in solid, old-fashioned country concerns credit is practically unknown in the retail drapery trade. With small businesses cash is universally the case. In an old-established country establishment nearly half the business done is credit, and therefore a longer profit is necessary. It is a common thing to find in such businesses that the majority of the customers are never off the books. The servant girl comes in for a dress, she pays £1 down, and the balance remains. When she has paid off that she wants something else, and so it goes on. The farmer's wife purchases £20 worth of goods for herself and her daughters. She pays £10, and by the time she pays the other £10 she wants another £15 worth of summer wear. An elaboration of this system is practised on an enormous scale particularly in the Midlands and Lancashire by tallymen, or "Scotch drapers," as they are usually designated. These descendants of the ancient packman or travelling draper have regular rounds of customers in

the districts in which they settle upon whom they call periodically with samples of dress-stuffs and drapery. The goods are delivered in the piece, or made up according to agreement, a sum is paid down, and the balance is collected in so many shillings weekly, fortnightly, or monthly as the case may be. Naturally, the purchaser has to pay considerably more than the value of the goods, but it is a convenience for poor people, and incidentally, the tallymen usually make small fortunes in a surprisingly short time.

The Bargain Sale. Twice a year, at least, the alert draper finds it necessary to institute a bargain sale. At the end of summer there is still on stock an accumulation of articles of a "summery" character which must be cleared. A light and airy summer creation in hats is no use for winter wear, and the fashion in hats will be totally different by the next summer. In like manner, when the spring sun begins to shine, the mantles, hats, coats, and furs of winter are undesirable, and the up-to-date man advertises his spring clearance sale. The experienced man, of course, marks his profits with a view to covering the losses incident from unseasonable stock being left on his hands, but, generally speaking, these bargain sales are very profitable transactions in spite of the "sacrifices." As a rule, however, the sales are genuine enough, in spite of popular cynicism. For at the time of the year, between seasons as it were, the wholesaler also is anxious to clear his surplus stock, and hats, for instance, that may have cost the retailer 2s. 6d. or 3s. each during the season, he may be able to purchase at 12s. per dozen. So that it may be stated by the retailer in all sincerity and with perfect truth that he is "now selling a hat at 1s. 6d. or 1s. 9d.," as the case may be, "which usually costs 4s. 6d." The periodical sales, however, are mainly useful in that they attract custom, and serve as outlets for remnants, oddments, and soiled stock. All that is wanted is an assortment of price tickets, and a stirring-up of neighbouring feminine curiosity by handbills, advertising in the local papers, mysterious preparations with brilliantly-lighted windows far into the night, and a preponderance of actual bargains.

The Secret of Drapery. One needs only to walk down the main street of any provincial town or suburb, or to stroll along the business streets in the West End of London to discover the secret of drapery. The observant stroller will note that the windows that attract most attention in any neighbourhood are those of the draper. The people who shop are the ladies, and if one sees a cluster of ladies congregated around a window, it is safe to assume that articles of feminine apparel are displayed therein. Other windows are glanced at casually, or, perhaps, something unusual attracts for a moment, but genuine interest is only attained when a well-dressed drapery window is reached. Thus the success of the draper depends, more than any other shopkeeper, on the variety, smartness, and magnetic properties of his window. The window show must be first of all attractive, but it must be varied constantly, and each show should be devoted entirely to one class of goods at a time.

Window Dressing. An arrangement of goods all of one colour is very attractive. In the summer nothing is more *chic* than a window dressed all in white. A draper should have the true eye for colours, as half a shade in colour makes all the difference between selling an article and not doing so. Therefore, if mixed colours are used, care must be taken that they harmonise [see also page 610].

A fresh window display every week, showing a varied assortment of ladies' wearing apparel, will make the reputation of a draper within a year for that particular branch of trade. But ladies' underwear should not be thrust in the public gaze until it palls. A variation of laces, Manchester goods, blouses and skirts, or stoles, in between make the ladies' outfitting—with its cherished profit—come like something quite new again. Then the wide-awake man in business very soon discovers the needs of his neighbourhood, and caters for these needs. The failure of small businesses is due in a great measure to this neglect in gauging the wants of those for whom the proprietors should provide, and the consequent accumulation of dead stock which, metaphorically, hangs like a millstone round the unfortunate draper's neck.

Trade Protection. The draper newly started on his own account, and anxious to take advantage of all that is offered for his advancement, may find it advantageous early in his career to join the association known as the Drapers' Chamber of Trade. The objects of the association are to give legal advice and protection from vexatious prosecutions to members who pay an annual subscription. The beginner whom we have in mind would pay 10s. per annum to the Association, and for that the Chamber undertakes to help him in legal matters connected with his business, by prosecuting persons who defraud him, and to give him the benefit of "central" offices where he can make appointments. If a member, he will likewise have the benefit of a Plate Glass Insurance Scheme which saves 30 per cent. of premiums to insurers, and the Chamber is pledged to assist in opposing injustices to the trade, such as postal "cash on delivery," manufacturers obtaining unjust monopolies, carriers repudiating liability, secret commissions to buyers, and Acts of Parliament being passed likely to hamper drapers in their business. The question of reductions in fire insurance, an alteration of the law of debt, parochial contracts and bogus drapery companies, also engage the attention of the Chamber, which, in short, is promoted to keep a keen watch on all matters affecting the trade. Until the employer has over twenty employees, his annual subscription would remain at 10s. When he has over 20 and under 100 employees it will be £1 1s., and £2 2s. when there are 100. The offices of the Chamber are at 155–6, Cheapside, London, E.C.

Adventitious Aids. Many a large drapery business has been built up solely on advertising. An energetic man, hampered by unenviable surroundings, has often extended his operations to the whole country by a system of careful newspaper advertising, which has brought him not only fame but fortune. The "mail-order business," as it is called, has developed enormously of recent years. Orders by post are solicited by striking newspaper advertisements, and if the advertiser gives prompt attention to orders, and strives to send an article with which his customer can find no reasonable fault—in short, gives good value for cash—he is bound to succeed. He would, of course, pay carriage on goods amounting to a stated sum in value, but many of the more progressive men have found it pay to send orders for any amount (even for half a yard of lace) post free. The draper who essays to do this class of business must, however, have the "gift of advertising." He must know how to tell the public crisply and pointedly what to buy and what he sells. His announcements must be distinctive and above all they must be persistent. A sudden and violent rush of sensational advertisements and then a sudden silence is likely to be worse than useless.

The Commercial. A good plan for the draper's assistant who aspires to proprietorship, and who would learn commercial wisdom in a good school, is to engage himself as a commercial traveller for a time to a reputable wholesale house. This is easier said than done. But if a young man sets out in life with a definite aim, he will be wise to keep this contingency in view as his ultimate period of service under an employer. Having gained an inside knowledge into retail methods in all departments of retail drapery—and their name is legion—he might attain to the coveted position of buyer in a large drapery establishment. Such a position brings him directly into contact with wholesale houses, and a smart man "of good appearance and address," according to the stock description, should have little difficulty in obtaining a post as provincial representative in a house that knows his value. Of course, most representatives are bred "in the house," but there are exceptions and the competent buyer who badly wants such a position should not have long to seek for it, even though he has not grown up with the business. The amount of business information and the varieties of methods which the observant commercial can acquire in his journeys through the country will prove invaluable when finally he launches into business on his own account.

The extent to which the drapery business may be developed is indicated by a walk through one of the large establishments in town or country. There will be found under the same roof and under the same control, departments—separate and distinct—devoted to baby linen, Berlin wool, clothing, outfitting, carpets, dressmaking, millinery, furs, gloves and hosiery, haberdashery, hats, silks, umbrellas, and sometimes furnishing, all of which are the subjects of individual articles in this course.

Transatlantic Methods. The hustling methods of our American cousins are much vaunted by some modern business men, and probably Britishers might learn something from the Americans. But American methods are slow of adoption in this country, and Britishers smile indulgently at Wanamaker's lectures to assistants "on the rules of business," "the conduct of business," or "the way to treat customers," preferring the less academic but more practical training of their forefathers. The card system for keeping the books is not catching on in this country, but the same system as applied to "follow-ups" is having something of a vogue in some quarters. The large and distinct departments into which the successful draper gradually divides his business make the application of this system possible, in that the heads of each department can "keep track of trade," and follow up with circular and otherwise any customer who has ever bought anything and has had occasion to leave name and address. In America, also, the "sales operator" is an institution practically unknown to this country. He takes in hand to get rid of your stock in the shortest possible time, at a profit, to make your sale "the most successful ever held," to write your advertisements, and to advise you generally. All of which may be very useful occasionally, but the fortunes in drapery, as in every other trade, are built up by men who know their own business best, and who have neglected none of the teachings learned in the hard school of personal experience.

Useful Literature. The man who desires to keep conversant with current events must subscribe to at least one of the many trade papers which deal solely with the drapery business. A series of useful business books are issued by the Home Trade Publishing Company, such as "Bookkeeping for Retail Drapers," 2s. 6d.; "Window Dressing for Outfitters," 2s. 6d., etc. Naismith's "Young Draper's Guide to Success," 1s. 6d., published by Gardner, of Paisley, contains many useful hints for beginners, while the more advanced man will have by him a copy of the "Draper's Dictionary," by S. W. Beck, which is published, at 3s. 6d., by Collinridge.

Continued

Group 20 MATERIALS & STRUCTURES 16 Continued from page 2200	STEEL-FRAMED STRUCTURES Cantilevers. Warren Girders. Lattice Girders. Trellis Girders. Braced Girders. Whipple-Murphy Trusses. Trussed Beams

By Professor HENRY ADAMS

Steel-framed Buildings. In a steel-framed building there will usually be three conditions of loading for the stanchions. Those in the interior have the heaviest load to carry, but it is generally applied symmetrically on two or four sides; those on the exterior, except the corner stanchions, will have two loads on opposite sides, and another load on a third side, and those at the corners will have two loads on adjoining sides. In the first case, the total load will be greatest, but will be nearly, if not quite, balanced; in the second case, the load will be less, but as it will be only partially balanced, the total effect will not be reduced; in the third case, the load will be still less, but will not be balanced at all, so that approximately each case will require the same size of stanchion.

Solid Steel Pillars. For intermediate supports to girders in shop fronts, theatre balconies, etc., the minimum obstruction to the view, with the requisite strength, is obtained by the use of solid steel cylindrical pillars, with cast-iron or cast-steel caps and bases. These pillars may be calculated by the formula

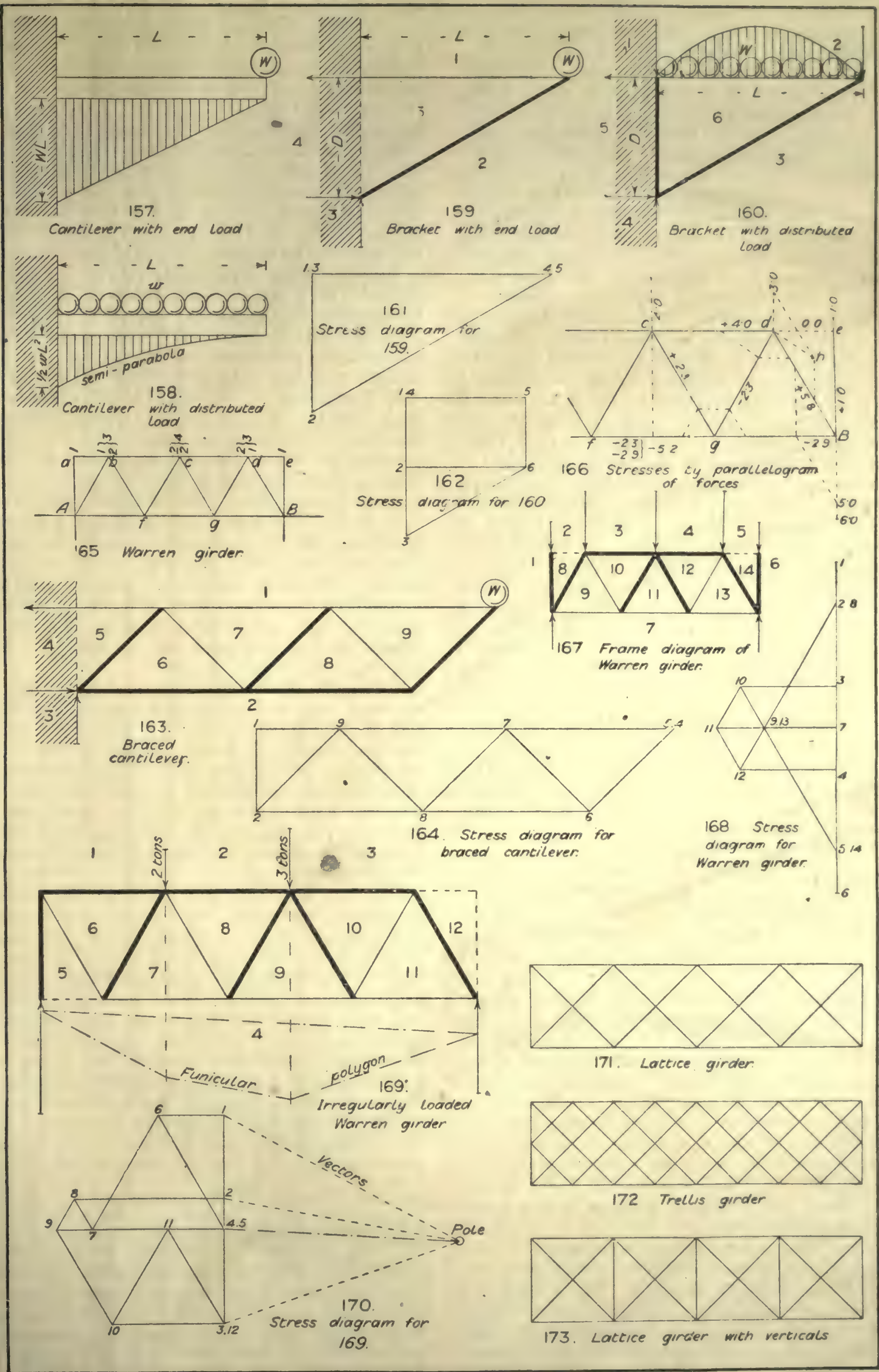
$$W = \frac{fA}{1 + a\left(\frac{l}{d}\right)^2},$$

where W = safe load in tons, f = safe compressive stress on short specimen = 5 for mild steel, A = sectional area in square inches, a = constant $\frac{1}{900}$ for ends flat and fixed, l = length in inches, and d = diameter in inches.

Cantilevers. Cantilevers may be in the form of beams, rolled joists, or girders built into a wall or rigidly connected at one end, with the other end free and projecting. The load supported by it may be concentrated at the free end or at any intermediate point, or may be uniformly or irregularly distributed along it. The load may be quiescent or "dead," it may be a vibrating or "live load," or it may be a more or less suddenly applied load producing impact or shock. All these varied conditions produce different amounts and distribution of stress. The more common cases are shown in **157**, where the maximum bending moment is equal to WL, and in **158**, where the maximum bending moment is equal to $\frac{1}{2}wL^2$, w being the load per foot run and L the span in feet.

Brackets. Brackets are cantilevers of more complex shape, the simplest being in the form of a triangle as **159** and **160**. Whatever the detail of the arrangement the principle of the stresses is as shown. Taking the case of **159** with a load at the end, the tension in the horizontal part will be $= W \times \frac{L}{D}$, and this will be the amount of horizontal pull on the wall at the top and thrust at the bottom. The weight also produces a downward thrust at the bottom = W. The thrust in the inclined portion will be $= W\frac{\sqrt{D^2+L^2}}{D}$. The stresses may be shown graphically by reciprocal diagram as in **161**. First number the spaces between the external forces 1, 2, 3, 4, and the internal space 5. Then in **161** draw the load-line 1–2 equal to the load to any given scale, and from points 1 and 2 draw lines 1–5 and 2–5 parallel to the lines in **159**, separating spaces 1–5 and 2–5. Then, 2–3 being equal to 1–2, point 3 will be the same as point 1, and as there will be no stress in 4–5 of **159**, these two points will come together in **161**. Scaling off the lengths of the lines in **161**, the stresses will be found to agree with those shown by calculation above.

The case of **160** cannot be completely determined by a reciprocal diagram alone, as these diagrams do not take account of transverse stress. In numbering the spaces the distributed load must be taken as equivalent to half concentrated at each end, so far as the stress on the frame is concerned—*viz.*, as forces 1–2 and 2–3; then in the reciprocal diagram **162** the load-line 1–2, 2–3 will first be drawn to scale, and point 6 will be found by drawing 2–6, 3–6 parallel to the corresponding lines in **160**. Then 1–5, 6–5, and lastly, 5–4, being equal to 1–5, 1 and 4 will be at the same point. Before going further it will be well to note that the nature of the stress is determined as explained in connection with the triangle of forces on page 1834. Taking the joint in **160** surrounded by the spaces 1, 2, 6, 5 (clockwise), 1–2 is a force of known direction acting downwards, then 2–6 in **162** is away from the joint indicating tension, 6–5 is towards the joint indicating compression, 5–1 is away from the joint indicating the pull at the wall. Again, taking the joint at 2, 3, 6, 2–3 acts downwards, then 3–6 acts towards the joint showing compression. The effect of the distributed load in producing transverse stress will be given by the bending moment formula $\frac{WL}{8}$ as in the case of a beam, which gives the height of the parabola in the centre. There are thus two forces acting, the direct tension and the transverse stress. These are combined by the formula $\frac{W}{A} \pm \frac{M}{Z}$, where W is the direct load, A is the sectional area of the upper member, Z its section modulus [page 1984], and M the maximum bending moment. The plus value will give the stress in the upper surface of the member, and the minus value that in the lower surface. One other point of difference between **159** and **160** should be noted.



157. Cantilever with end load

159. Bracket with end load

160. Bracket with distributed load

158. Cantilever with distributed load

161. Stress diagram for 159.

162. Stress diagram for 160

165. Warren girder

166. Stresses by parallelogram of forces

167. Frame diagram of Warren girder

163. Braced cantilever.

164. Stress diagram for braced cantilever.

168. Stress diagram for Warren girder

169. Irregularly loaded Warren girder

170. Stress diagram for 169.

171. Lattice girder

172. Trellis girder

173. Lattice girder with verticals

STRESSES IN GIRDERS

The wall piece in **159**—*viz.*, 4–5—has no stress, while in **160** it is in compression due to carrying half the load.

Braced Cantilever. The reciprocal diagram affords a ready means of ascertaining the stresses in a braced cantilever as **163**. Draw the load-line 1–2 in **164**, then note that point 9 must be next found by drawing lines 1–9, 2–9; then 9–8, 2–8, and so on, always working from two known points to obtain the unknown third point. The remainder presents no difficulty. The nature of the stresses may be conveniently indicated on what is called the *frame diagram*, **163**, by thin lines for tension, thick lines for compression, and dotted lines for no stress.

Braced Beams. A short braced girder in three bays of the Warren type is shown in **165**. Taking the load as 12 tons distributed along the top flange, there will be four tons on each complete bay, so that the distribution will be as marked and the reactions will each amount to half the total load—*viz.*, six tons. A little more than half this girder is shown in **166**, and the method of finding the stresses by parallelogram of forces is indicated by dotted lines, commencement being made at the abutment. A load of one ton from the end pillar does not pass through any of the bracing, so that this being deducted from the reaction, leaves five tons to be resolved into the directions B*g* and B*d*. Tension and compression may be conveniently indicated by the signs − and +. Transferring the stress in B*d* to its upper end, it is combined with the load on *d* to give the resultant *hd*; then the stress in *hd* is resolved into the directions *dg* and *dc*. The stress in *dg* is then transferred to the lower end, and its effect found in the directions of *gc* and *gf*. In the latter case the stress in B*g* must be added to give the total stress as shown by the figures below. The same method may be continued through to the other abutment, when the reaction there will be found to balance exactly the stresses in the bars meeting at that point. This method is not so simple or convenient as that to be now described, but there are cases where it will sometimes throw light upon doubtful cases and enable them to be worked out satisfactorily.

Girder Stresses by Reciprocal Diagram. The same girder [**165**] may now be taken to illustrate the use of reciprocal diagrams. It is shown in **167** prepared as a *frame diagram*, and **168** shows the corresponding *reciprocal stress diagram*.

Another girder with irregular loading is shown in **169** prepared as a frame diagram. The reactions may be calculated or found graphically as follows. The line of loads 1–2, 2–3 is drawn to scale in **170**, a pole, 0, is taken at any point and vectors drawn from points 1, 2, 3, the force lines in **169** are produced, and anywhere on the reaction 1–4, as at A, a commencement is made for the funicular polygon. Then, from A, parallel to the vector from 1, a line is drawn across space 1; this is continued across space 2 by a line parallel to the vector from point 2, and across space 3 parallel to vector from 3, meeting the other reaction in B. Join BA and from the pole 0 draw a parallel line to cut the load-line in 4, then 3–4 will be the reaction on the right-hand side in **169** and 4–1 the reaction on the left-hand side. Having found point 4 on the load-line, the reciprocal diagram may be completed as shown without further difficulty, except that 4–5 will come at the same point, showing no stress in that bar, and 3–12 will also occur at one point. Although there will be theoretically no stress in these bars they are put in for appearance and to provide against contingencies.

Lattice and Trellis Girders. Lattice girders [**171**] and trellis girders [**172**] may be worked in precisely the same way. Lattice girders with verticals [**173**] are strictly indeterminate structures, as the stresses in the various members depend to some extent upon the workmanship. It is generally assumed that half the load upon any apex, whether tension or compression, passes through the vertical member, and this is borne out by investigation when the girder is divided into its two component forms with half the load taken upon each. The method of doing this is shown in **174** and **176**, the corresponding stress diagrams being **175** and **177**. The sum of the stresses being collected, a single stress diagram may be constructed from them as in **178**, which is to a smaller scale. This form of girder has been largely used for bridges, as, for example, the Charing Cross railway bridge.

Whipple-Murphy Truss. Other types of girder, such as the Pratt [**179**], the Howe [**180**], and the modified Pratt [**181**], have been used very frequently for timber bridges in America, but the type perhaps most favoured at the present time for steel construction in spans of 60 ft. to 100 ft. is the Whipple-Murphy truss [**182**], also known as the Linville system. The calculation of the stresses in this girder occupy many closely printed pages in works on structural mechanics, but the principle just illustrated of dividing a complex girder into its component parts, each with its due share of the total load, may be conveniently applied to this case.

Trussed Beams. A simple trussed beam, as **183**, is used for trussed purlins, small gantries, etc. The frame diagram shows that the distributed load must be indicated by force lines of the proper value over each of the points of support, and the stress diagram [**184**] may then be drawn. When the end thrust in the horizontal member is scaled off, it must be combined with the bending moment of the load between the points of support producing a transverse stress by the formula already given—*viz.*, $\frac{W}{A} \pm \frac{M}{Z}$.
For large spans it is necessary to have two struts, as in **185**, and the stress diagram for a uniformly distributed dead load is shown in **186**. With an irregularly loaded or partially loaded beam, or a rolling load, the truss will require bracing between the two struts, otherwise, when the load is over one strut, there will be a tendency to lift the other strut

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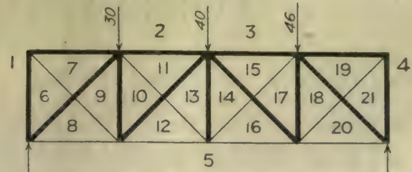
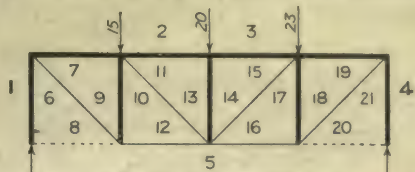
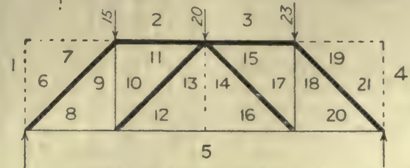


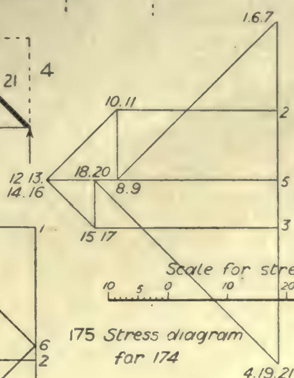
173. Lattice girder with verticals.



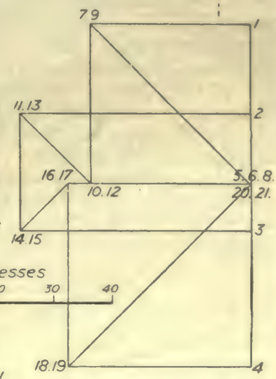
176 Second component part of 173.



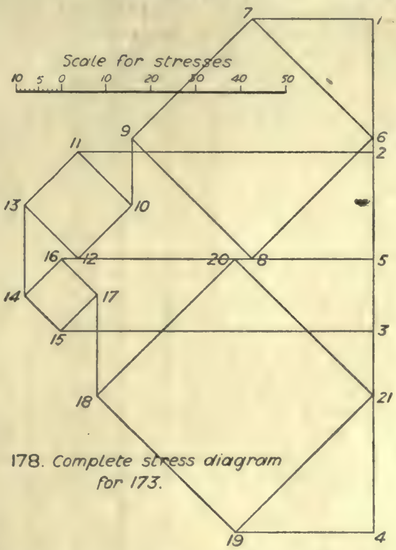
174 First component part of 173.



175 Stress diagram for 174

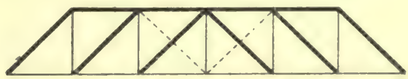


177 Stress diagram for 176.



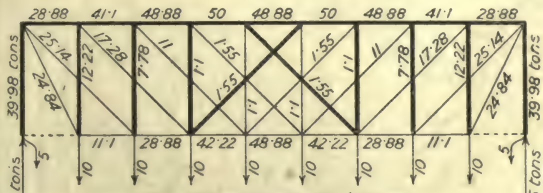
178. Complete stress diagram for 173.

179. Pratt Truss.

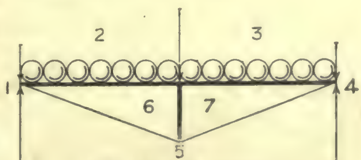


180. Howe Truss.

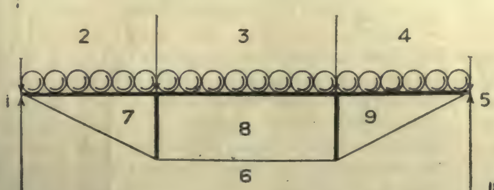
181. Modified Pratt Truss



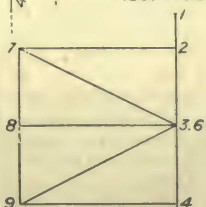
182. Whipple-Murphy Truss
with stresses for distributed load of 90 tons.



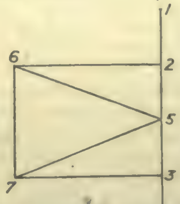
183. Trussed beam.



185. Trussed beam with two struts.



186. Stress diagram for 185.



184. Stress diagram for 183.

BRACED GIRDERS AND TRUSSED BEAMS

Group 13 **GEOGRAPHY** 16 Continued from page 2167	# ITALY, SPAIN, & PORTUGAL **Build of Italy. Climate, Products, Towns, and Features of Interest. Physical Characteristics and Towns of the Iberian Peninsula**

By Dr. A. J. HERBERTSON, M.A., and F. D. HERBERTSON, B.A.

ITALY

From the summit of any lofty Alpine peak south of the Rhone Valley—Monte Rosa, for example—a wonderful view is seen to the south. Vast and blue extend the plains of Piedmont and Lombardy, rich lands built up in the course of untold ages at the southern base of the Alps, and formed of the sediment carried down by the rivers descending from their snow-fields and glaciers to the Po, which, on a clear day, may be made out like a silver thread in the blue distance. The valleys opening to this plain are even more beautiful than those opening north, and the lakes which fill many of their lower ends—Maggiore, Lugano, Como, Garda, and smaller ones—have an indescribable charm of southern loveliness.

West of the Adige, all the Alpine streams descend to the Po, which flows almost due east to the shallow Adriatic, into which its delta is steadily pushing. Its tributaries on the southern bank come from the Apennines. These mountains, which form the backbone of Italy, spring from the Maritime Alps, skirt the shore of Liguria, and broaden out across the centre of the boot-shaped peninsula, leaving narrow lowlands along the sea on either side. The island of Sicily, separated from Calabria by the Strait of Messina, is structurally a continuation of the Italian peninsula. The mountainous islands of Corsica (French) and Sardinia, separated by the Strait of Bonifacio, rise out of deep seas to the west.

Climate and Products. The climate of Italy (110,500 sq. miles) is everywhere genial, and Sicily enjoys something not unlike perpetual summer. The severest winters occur in the plains north of the Apennines, but even there frost never lasts long. The summers are everywhere hot. Round the northern plains the rainfall is about 40 in. a year, and fairly uniform at all seasons. Further south it diminishes considerably, and occurs chiefly in winter. Evergreens replace deciduous trees, and the cypress, stone-pine, and evergreen oak give a wholly new character to the landscape. The characteristic Italian tree is the olive, which is grown, along with vine and mulberry, in the valleys opening to the plain of the Po, but not on the plain itself, owing to the severity of the winter. In summer this plain is hot enough for cotton and rice to be grown. The vine is cultivated everywhere. Maize is a common cereal, and a special hard wheat, used for macaroni, is grown in the south in Apulia. Agriculture is the principal occupation, but manufactures—silk and other textiles, engineering, and electrical works—are rapidly becoming very important in the northern plain, which is the most prosperous and progressive part of Italy.

Northern Italy. The traveller enters Italy either by the Mont Cenis route, which brings him to Turin, with its streets like the squares of a chessboard and its fine view of the neighbouring Alps, or by the St. Gotthard route, which brings him to Milan, with its brown roofs, many bell-towers, and immense cathedral of white marble. Milan is the busiest town of Italy, silk being the most important of its many manufactures. From Milan we may go east by Verona, at the end of the Brenner route, and the old university city of Padua, to Venice, a city of lagoons and islands, with the magnificent cathedral of St. Mark, and, instead of streets, canals flowing between lines of palaces. Or, instead, we may go south, cross the Po at Piacenza, and pass by the famous old towns of Parma and Modena to the picturesque university city of Bologna, built at the base of the Apennines, and commanding the route across them into Tuscany. In either case we traverse a vast fertile plain, enclosed between the Alps and Apennines, crossed by a network of irrigation canals, and green with rich crops of cereals and fruits of many kinds.

Liguria and Tuscany. These provinces lie west of the Apennines. Liguria is favoured both in scenery and climate. The mountains which shut it in on all sides except the south keep off all cold winds, and its rocky shores are a dream of sunlit beauty. Genoa, often called the "Queen of the Mediterranean," is a city of palaces, built round a magnificent bay backed by mountains. Its commerce is enormous. Further south is Spezzia, the Italian naval station.

Tuscany slopes from the crest of the Apennines to the blue waters of the Mediterranean. Its largest river is the Arno, on which is Florence, a city no less famous for art treasures than for natural beauty, built a little below the point where the Arno leaves the Apennines. Near the mouth of the Arno is Pisa, with a grand cathedral and the famous leaning tower, once a prosperous port, but long superseded by Leghorn (Livorno) to the south. North of Pisa is Lucca, famous for oil. All Tuscany is hilly, and many of the towns—small, but often rich in masterpieces of architecture and painting—are built on the crest of steep hills above terraces of vineyards and olive yards, which yield the famous Tuscan wine and oil. Such a city is Siena, with a magnificent cathedral and art galleries.

The Tiber Basin. Similar in character, but less fertile, is Umbria, the basin of the Upper

99. ITALY

Tiber. The most famous cities are the hill towns of Perugia and Assisi, both rich in art treasures. The Lower Tiber opens to the wide plain of the Roman Campagna, once richly cultivated and densely peopled, but now covered with ruins, and inhabited only by scattered shepherds.

The Eternal City. Rome, world famous for 2,500 years, is built on several low hills rising out of the level Campagna, which, except on the seaward side, is shut in by wooded mountains. To the stranger entering it by rail it looks a modern city, but his first drive overwhelms him with monuments of Pagan splendour—the Forum, with its ruined temples; the great amphitheatre of the Coliseum, triumphal arches and columns, pillars of heathen temples built into Christian churches, the long avenue of Roman tombs lining the Appian Way, and the great ruined aqueduct stretching across the

Campagna. Innumerable magnificent churches and palaces and the immense cathedral of St. Peter's tell of the splendour of Papal Rome. In every sense it deserves the name of the Eternal City.

The Campagna of Naples. This is separated from the Roman Campagna by a tract of marshes, which are rendered uninhabitable by malaria, the scourge of Italy. Naples is built on a magnificent bay near the base of Vesuvius, an active volcano whose eruptions are often on a most disastrous scale. The surrounding plain is one of the most fertile parts of Italy. The coast is famous for its beauty, especially about Amalfi and Salerno.

On the opposite side of the Apennines are the thinly-peopled mountain lands of the Marches and the Abruzzi and the fertile lowlands of Apulia, with many good harbours, including Brindisi, the terminus of the overland route to the East.

Calabria, the toe of the Italian boot, is a thinly-peopled mountain region, with picturesque towns on the coast.

The Italian Islands. Sicily, south of Calabria, is the garden of Italy. Agriculture is backward, but the fine volcanic soil is extraordinarily fertile. Cereals and fruits, especially orange and lemon, come to perfection, and in old times Sicily was the granary of the world. In the north-east is the active volcano Etna, over 10,000 feet high. Sulphur is abundant, and exported in large quantities. The chief towns, all on the coast, are Messina, on the strait; Catania, at the base of Etna; and Palermo, on the north coast.

North of Sicily are the volcanic Lipari islands, one of which, Stromboli, is often called the Lighthouse of the Mediterranean. South of Sicily are the British islands of Malta, with the fortified naval station of Valetta, and Gozo. Early vegetables are grown.

Sardinia, the only other important island, is mountainous and thinly peopled. Agriculture is backward, but the soil is fertile. The mining of iron and other ores is carried on, and also in the small island of Elba, off the coast of Tuscany.

SPAIN AND PORTUGAL

Iberia. This name is commonly given to the westernmost of the Mediterranean peninsulas, which is divided politically into the kingdoms of Spain (192,000 sq. miles) and Portugal (34,500 sq. miles). The only land frontier of Iberia is in the north-east, where the Pyrenees form the frontier of France for over 250 miles. On the north, west, and south-west it is washed by the Atlantic, and on the east and south-east by the Mediterranean, the two being connected by the narrow Strait of Gibraltar, where the fortified rock of Gibraltar guards for Britain the road to India.

Mountains and Rivers. Next to Switzerland, Iberia is the loftiest region in Europe, only a small part of the peninsula being less than 1,500 ft. above the sea. The Pyrenees are continued in the east to the south-west by the mountains of Catalonia, and in the west by the Cantabrian Mountains, rich in iron and other minerals, and rising steeply above the Bay of Biscay. From the western and eastern ends respectively of the Cantabrian Mountains come two important rivers—the Minho, flowing south-west to the Atlantic, and forming part of the boundary between Spain and Portugal, and the Ebro, flowing south-east to the Mediterranean across the large lowland of Aragon. West of the Ebro rises the Meseta, an immense lofty plateau, with a general elevation of over 2,000 ft., forming the core of the peninsula. It is highest in the east, and the rivers which flow to the Mediterranean are consequently short and rapid. The longer rivers—the Douro, Tagus, and Guadiana—follow the westerly slope of the Meseta to the Atlantic, flowing in deep gorges sunk below the level of the surrounding country. They are consequently difficult to cross, and as they are too swift and shallow to be navigable, they are useless as a means of communication. Jagged lines of heights called sierras (Sp. *sierra*, saw), rising some 5,000 ft. above the Meseta, separate them from one another. South of the Guadiana the southern margin of the Meseta, called the Sierra Morena, descends steeply to the lowland of Andalusia, which is crossed by the Guadalquivir, the most important river in the peninsula. Its waters come from the Sierra Morena and the Sierra Nevada, the latter forming the south-east heights of Spain. This lowland and that of Southern Portugal, round the Lower Douro, are the most important lowlands of the peninsula. Those of the east coast are small, but highly cultivated, especially in Murcia and Valencia.

Natural Regions. Iberia consists of three well-marked regions—(1) the Pyrenees region, including the Catalonian and Cantabrian Mountains; (2) the Meseta; (3) the Andalusian region, with the lowlands of Southern Portugal and South-eastern Spain.

The Pyrenees. The Pyrenees region belongs in climate and vegetation to Central Europe. The rainfall of the Cantabrian Mountains is heavy, while the rest of Iberia is very dry. The seaward slopes are densely forested with deciduous trees. The summers are warm, but frosts are common in winter. All the plants of Central Europe can be grown, including the vine and apple, from which wine and cider are made.

The Meseta. The Meseta is high, bleak, dry, and extreme in climate. The temperature of Madrid varies from a maximum of 104° in summer to a minimum of 14° in winter, a range of 90°. Evergreens replace deciduous trees, and in the lower west vast numbers of swine are fed in the evergreen oak forests of Estremadura. A valuable species is the cork oak, whose bark furnishes cork. The higher parts of the Meseta are too bleak for trees. Much is covered with poor grass or low evergreen aromatic plants, which supply thousands of sheep and goats with their summer pastures. Agriculture is backward, and much fertile land is unused. Water for irrigation is difficult to obtain, as the

100. THE IBERIAN PENINSULA: SPAIN AND PORTUGAL

rivers are deeply sunk in inaccessible rocky gorges. Wheat is grown where ground-water is found near the surface, but under less favourable conditions only barley, oats or rye are sufficiently hardy.

Andalusia. Andalusia and the other lowlands of the south differ from both these regions. The climate resembles that of Northern Africa, and in the better parts are grown many plants belonging to the tropics. Among these are the date, which ripens at Elche in Valencia, the banana, sugar-cane, sweet potato, cotton, and, in swampy districts, rice. The orange, fig, mulberry, and other Mediterranean fruits are almost wild. Some wheat and maize and many pulses are grown. The vine is very extensively cultivated. The ports of Portugal and the sherries of Southern Spain are world famous. Raisins, or dried grapes, and dried figs, are exported in immense quantities from the ports of Valencia and Murcia, where much attention is devoted to irrigation and agriculture. "The rock has to be blasted and then powdered with hammers to form soil, the slopes of all the hillsides are terraced, and every fertilising agent, even the sweepings of the streets, is utilised." Unfortunately such a spirit of enterprise is rare in Spain. The agriculture of Andalusia is backward, though its mines, largely developed by foreign capital, are prosperous. It is famous, too, for its bulls and horses.

Towns. Towns are more numerous on the coast than on the plateau, which is thinly peopled. On the north coast are the ports of Bilbao and Santander, exporting iron. In the Douro basin are Valladolid, in the middle of the plateau, commanding the route to Madrid across the Castilian mountains, and Oporto, on the coast of Portugal, exporting port wine. In the Tagus basin are Madrid, the capital, in the middle of the plateau among bleak surroundings; Toledo, finely situated above the river, and long famous for fine swords; and Lisbon, the capital of Portugal, built on hills at the mouth of the broad Tagus. There are no towns of importance in the Guadiana basin, but a little further east is Huelva, which exports the copper of the Rio Tinto copper mines of the Sierra Morena. The Guadalquivir recalls the Oriental magnificence of the Moorish conquerers of Spain. Granada, at the base of the Sierra Nevada, contains the Alhambra, one of the most exquisitely beautiful buildings in the world. Cordova has a magnificent cathedral, once a mosque. Seville is the most prosperous city of Andalusia, with tobacco and manufactures, and a large trade. All the ports of the south and south-east coast—Cadiz, Malaga, Almeria, Cartagena, Alicante, and Valencia—trade in fruit and oil. Cadiz exports the sherry of Xeres. Barcelona is the chief city and port of Catalonia, the one part of Spain which is progressing industrially. Its manufactures and trade are very important.

101. ANDALUSIA

Off the east coast are the Balearic Islands. The largest town is Palma, on Majorca, the largest island.

Continued

BRITISH BREEDS OF CATTLE

The Most Suitable Breeds for Beef and Milking. Oxen for Farm Work. Breeding. Care of the Calf. Indications of Age

Continued from page 2079

By Professor JAMES LONG

THE varieties of cattle bred in the British Islands are unquestionably superior, as a group, to those bred in any other part of the world. There is nothing comparable with the Shorthorn or the Hereford, the Devon or the Aberdeen Angus, as meat producers, or with the Shorthorn, the Ayrshire, the Jersey, and the Guernsey, as milkers, among the scores of varieties which abound on the European continent. Our leading breeds are precisely those which have been imported into America, our Colonies, and foreign countries for the improvement of local stock, and thus it is that we have been supplied with superior beef and dairy produce for the feeding of our people.

The Shorthorn. The Cattle King is the Shorthorn [page 22]. It is at once, if we embrace the pedigreed and the unpedigreed stock, the most useful, general purpose beast best known to men. It thrives on almost any soil, and in every climate. Known as the Durham on the Continent, it is a beef producer of the first rank; it improves almost every race or mongrel when employed as a cross, and in the shape of the well-known dairy Shorthorn of our country it is perhaps the best milker which is known, if we estimate the value on the basis of the quantity as well as the quality of its milk. It varies in colour from red, white, and roan, to combinations of reds and whites, and roans and whites.

The Shorthorn is a beast of gentle disposition, a rapid feeder, carrying a soft, mellow skin and a silky coat. It is square in build, with straight top and bottom lines; neat, small, curved horns; great width of loin and hind quarters; deep, well-sprung ribs; ample girth round the heart; full eyes; neat, well-formed head, with a somewhat large muzzle, adapting it as a powerful grazer. The weight of the fat Shorthorn may be better realised from examples. At the Smithfield Fat Cattle Show of 1905 the King's champion heifer weighed 16 cwts. 3 qrs. 20 lb. at two years eleven months old, having thus made a gain in live weight of 1·8 lb. daily from birth. His Majesty's champion steer, aged two years nine and a half months, reached the extraordinary weight of 19 cwts. 1 qr. 25 lb. The best milking cow unpedigreed at the National Dairy Show in the same year produced six gallons of milk in the milking trials and 2 lb. 13 oz. of butter in the official test. In Lincolnshire a variety of Shorthorns, known as the Lincoln Red [page 431], is bred for beef and milk production. The most famous milking herd of this breed is owned by Mr. John Evens, of Burton, and, numbering forty-three head of cows, produced an average yield, in 1904, of 842 gallons, while the same herd, with the same number of animals, averaged 889 gallons in 1896. Mr. Evens's marvellous results are the work of successful breeding on the principle of selection during some fifteen years.

The Hereford. Practically a local breed confined to Hereford and a few adjacent counties, the Hereford is, nevertheless, bred largely in America and the Colonies, its value for crossing for beef production being almost as remarkable as that of the Shorthorn. In colour it is dark red and white, the white markings being quite characteristic, and covering the head, crest, chest, belly, tail-end, and often the feet and legs as high as the knees. The horns are rather long and spread. The disposition is gentle, the skin mellow, the buttocks full, and the body deep, thick, and blocky. The Hereford is hardy, and useful as a working ox, but the cows are poor milkers, sometimes being unable to properly rear their calves. The champion steer of 1905, owned by the King, weighed 17½ cwts. at the age of two years nine months; but the heaviest animal at Smithfield in the same year was Lord Coventry's steer, aged two years eight and three-quarter months, weighing 18 cwts. 2 qrs. 7 lb.

The Sussex. A dark red animal, of a rather long-horned race of coarser type, still used as a working ox on the Sussex Downs, is called the Sussex. It has been much improved during the last decade, but much is needed before it can be regarded as a symmetrical beast. It is massive in appearance, hardy in constitution, matures early, and produces meat with less fat than some of the more famous breeds. The cows are poor milkers, while the variety is chiefly confined to Sussex and its vicinity.

The Devon. The variety called the Devon is similar in colour to the Sussex, being a rich dark red, and presenting a mottled appearance with its new coat. It is, however, smaller, and more compact, with good, symmetrical lines and meat of high quality. It does not reach so great a weight for age as the Shorthorns, the Herefords, or the Aberdeens, but is largely bred in Somerset and Devon, as well as in many other parts of the country. The horn is stout in the male, though finer in the female, and of medium length. The Devon is quite a moderate milker, but hardy, profitable, and attractive, feeding well for the butcher.

The South Ham. A sub-variety of the Devon is known as the South Ham. This animal is chiefly bred in South Devon, and perhaps more extensively for milk than for beef production. It possesses a rich, soft, yellow skin, is a large producer of unusually rich milk, and is mainly responsible for the richly-coloured butter and

clotted cream so largely produced in that part of England. Perhaps the finest herd of South Devon cattle is that owned by Mr. Vosper, of Merafield, near Plympton, and numbering 200 head.

The Longhorn. The most picturesque of English varieties is the Longhorn. It is a big, plainly-formed animal, with a huge curved horn growing downwards and inwards, while it varies in colour between brindle, roan, red, and even pied. The variety, long neglected, is being revived, but much is needed before it can be regarded as an animal of the first rank. The steers reach great weights, but do not carry sufficient meat on the best parts, while the cows are poor milkers.

The Red Poll. The Red Polled cattle are peculiar to East Anglia [page 432]. They are hornless, a rich chestnut red in colour, compact, and sometimes even massive, of medium height, symmetrical in form, docile in disposition, hardy, and capital feeders, producing most excellent beef. Some strains of blood produce milkers of a high order, the milk being of slightly more than average quality. At Smithfield, in 1905, steers approximately two years old weighed from 10½ to 12 cwts., while those just under three years varied from 13 to 15½ cwts. alive. Heifers from two years four months to two years ten months vary from 11 to 15 cwts.

Welsh Cattle. Similar as a group, Welsh cattle [page 432] are more or less divided into local varieties. As a rule they are black; in many cases very large in size, but plain in form and wanting in compactness and quality on the best parts of the carcase. The breed is, however, gradually improving by careful selection. The Welsh are long-horned, somewhat coarse, and slow feeders, although large numbers of steers—generally known as "runts"—are brought into England for grazing and fattening purposes. Some strains of blood produce cows of good milking character. Steers approximately two years old will reach 11½ to 14 cwts., while those just under three years old vary from 13½ to 18¾ cwts., a figure reached by a steer at Smithfield, in 1905, aged two years eleven months, the champion of the breed at the same exhibition reaching 16½ cwts. at two years ten and a half months. The heifers vary from 11½ to 16¾ cwts. at two years and three years respectively.

Among the local varieties are the Pembrokes, or South Welsh cattle, some of which are coloured, or black and white; the Castle Martins, and the Glamorgans, which are black and white, or red.

The Aberdeen Angus. The well-known Scottish cattle, the Aberdeen Angus [page 432], are among the choicest of British varieties, frequently gaining the championship at the fat stock shows of the country. They are excelled in form and quality by no known breed, producing the best of beef, but they are poor milkers. The Aberdeens, which are black and hornless, are known as "Doddies." They are extremely symmetrical, with straight top and bottom lines, well-formed quarters, and great depth and girth round the heart. When used for crossing, they immensely improve the stock produced, as well by their quality as by their hardiness. The champion at Smithfield in 1905 was an Aberdeen heifer, weighing 16¼ cwts. at two years ten and three-quarter months. Steers just under two varied in weight from 11¼ to 13 cwts., while steers just under three varied from 15¼ to 17 cwts., and heifers between two and a half and three years old from 12 to 16½ cwts. alive.

The Galloway Cattle. Closely resembling the Aberdeens, being black and polled, the Galloway cattle are coarser in quality and coat, while they are less symmetrically built. They are very hardy, well adapted—in part owing to their longer and warmer coat—to exposure, but they are poor milkers, although making excellent crosses with the Shorthorn, producing the blue-grey cattle so favoured by breeders of stock intended for the butcher. The champion Galloway heifer at Smithfield in 1905 weighed 13¾ cwts. at two years eleven and a quarter months old; steers just under two years reached from 10 to 14 cwts., while those under three reached from 11½ to 15 cwts. alive.

West Highland Cattle. The most picturesque of any breed are the West Highland cattle [page 432]. They possess large-spread horns, long, shaggy coats of curious shades of colour, which, apart from the blacks, which predominate, include red, yellow, dun, and brindled. They are extremely hardy, and used to exposure, but they mature slowly, although they produce beef of the highest class. They stand low on the legs, but are square, rather compact, and are fancied by many landowners and well-to-do farmers, who bring them from Scotland for grazing in parks and on good feeding pastures. The champion heifer at Smithfield in 1905 weighed 14 cwts. at three years eight months old. Steers from two and a half to three years varied from 11½ to 14¾ cwts., while oxen over three years reached 17¾ cwts. alive.

Ayrshires. The Ayrshire breed, the famous cheesemaker of the West of Scotland, is an animal of medium size and varied colour—brown, red, and black, usually patched upon a white ground. It is of an active and yet gentle disposition, and essentially a dairy breed, although the steers at two years old reach 10 cwts. The Ayrshire possesses prominent horns, which grow wide apart, upwards and outwards. The body is wedge-shaped, the front especially fine, the head long, and the udder broad, lengthy, and flat, but the teats are small. This breed is more fully described in Dairy Farming.

Jersey, Guernsey, and Dexter. Being essentially milking breeds, the Jersey, Guernsey [page 431], and Dexter [page 256] are cattle also described in the section on Dairying. In neither case are the steers or the cows, when barren, profitable as butcher's beasts. Both Dexters and Kerries, however, are occasionally crossed with a beef producing variety, and with better results than are obtained when either are kept pure. These results are, nevertheless, much inferior to those which are achieved by breeding from the recognised beef producing varieties.

TYPICAL BREEDS OF BRITISH CATTLE
1. Devon Bull 2. Shorthorn Cow 3. Hereford Bull 4. Jersey Cow 5. Kerry Cow 6. Sussex Bull
7. Ayrshire Cow 8. Longhorn Heifer

Shetland. The Shetland cattle are tiny, shaggy-coated cattle, of varied colours, useful under the conditions in which they are kept for the production of milk and meat, but neither can be regarded as economical stock worthy of recommendation outside the limits of their native home. Great improvement, however, might be effected by the employment of suitable, selected bulls.

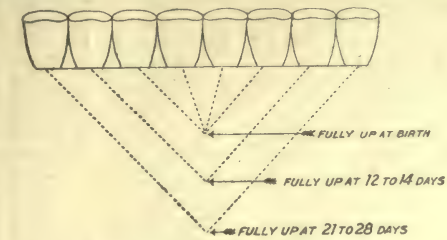
Feeding Cattle. Although the principles of feeding are separately discussed in a later lesson, brief reference may here be made to the practice of feeding cattle. Cattle are kept for the production of milk or meat, or both. It is essential, therefore, to supply food in such quantities, and at such times, as will best promote a successful result. The food chiefly employed for fattening purposes are linseed cake, to which a small proportion of cotton cake is sometimes added, maizemeal, barleymeal, turnips and mangels, with chopped hay or straw, or both. Fatting cattle are frequently fed side by side from a manger, or in specially constructed boxes, the floor of which is daily littered, until the manure is collected to such an extent that it becomes essential to remove it. This manure is of higher value than any produced on the farm. In all cases, cattle need protection; exposure to cold winds and rain being followed by slight decreases in weight, or by the consumption of increased quantities of food. Cattle are frequently fed for the butcher on summer and autumn pastures, receiving daily rations in the fields. The result, however, depends much upon the pastures, some of which produce richer and more abundant herbage than others, and are known as being capable of fattening a bullock. It is a common practice either to bring in stock from grass, or to purchase a given number of head year after year for stall feeding, to be sold during the winter months, the Christmas season being often selected. The success of the feeder depends much upon the class of cattle which he purchases or breeds. Crosses with the Shorthorns, Hereford, Devon, Aberdeen, Galloway, Red Poll, Sussex, or pure-bred animals of these varieties, make the best and most profitable beef. The artificial food required, such as cake, should be purchased during the summer, when prices are low, and supplied in weighed quantities with the chaff and roots, which should be sliced or pulped. Cattle which thrive best are those which are docile, contented, chewing their cud in the fields, and stretching and licking themselves when they rise. Unthrifty cattle are easily recognised by their staring coats, their uncomfortable and unthrifty appearance, their distended abdomens, and especially by the fact that after a few weeks of good feeding they gain insufficient weight to pay for the cost of their food. For these reasons, the weighbridge is a valuable adjunct to the farm.

Breeding and Calving. Cattle of the two sexes are variably described at different ages. The male calf is a bull calf, becoming a bullock, stirk, or steer after castration. After reaching twelve months, he is known as a yearling bull, steer, or bullock; after reaching two years, he is a two-year-old, and after reaching three years, he becomes a three-year-old steer, bullock, or ox, the last-named being the more appropriate term. A female at birth is a cow-calf, heifer-calf, or, as in Scotland, a quey-calf. Having reached twelve months, she becomes a one-year-old heifer or quey; on attaining two years she is termed a two-year-old heifer or quey; while at three years old she is a three-year-old heifer or quey, unless she has had a calf, when the term, applied in accordance with the locality, is cow or heifer with first calf. A "maiden" heifer is a heifer which, being adult, has not been crossed by the male. A cow which is in-calf, is known as an "in-calfer," while a cow which, having borne calves, is neither in-calf nor in milk, is a "barrener." When twin calves are born, one of each sex, the female is known as a "free-martin."

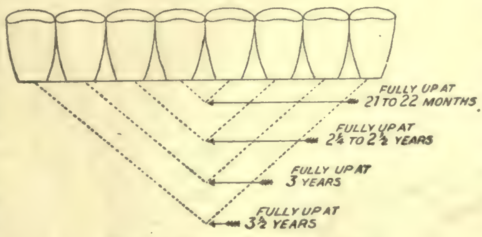
A cow usually comes in season every three weeks until she is in-calf. There are, however, occasional exceptions. When she is near calving, the udder gradually increases in size, extending to the full when the date has been closely reached. The vent, too, swells, especially when close to parturition. Fleshy cows, or cows which are suspected of a leaning to parturient fever, or "drop," are better placed upon short commons—such as scanty pastures—for a few weeks before calving. In some cases it is advisable to drench these cattle with Epsom salts two or three times during the last few days. When a cow is about to calve—a condition which cannot be mistaken—she should be taken to a box ready prepared for her reception, the floors and walls having been purified and the former strewn with clean wheat or oat straw. She should not be tied up, nor assisted until it is recognised that help is needed. Should she be unable to expel the calf, a stout cord may be passed around its legs just above the feet, and gently yet firmly pulled each time the cow gives a throe. This plan is usually successful. If it is not, the help of a thoroughly experienced veterinarian should be called in. After calving, the dam and her calf should be left alone. The mother will lick her calf, and subsequently turn to a warm bran mash, which may be supplied to strengthen her. The attendant, however, should watch for the expulsion of the "placenta," or cleansing, which some animals have a habit of eating.

Feeding Calves. Although there should be no coddling, the newly-calved cow may be protected with a rug during cold or draughty weather. The calf should be allowed to take the first milk, known as the "bestings," or colostrum, which possesses a natural and beneficial action. Whether a calf should be allowed to suck its dam until weaning is within the province of the owner to determine. We would, however, point out that this is the most extravagant method of rearing stock. Where calves are fed for veal, a single heavy milking cow may rear four or five calves in succession. When rearing for stock, a deep milker will sometimes rear two on the udder. A better plan, however, is to wean a calf at birth, and teach it to drink. The quantity of milk supplied may then be accurately determined, and the cost of rearing ascertained.

A newly-born calf will consume at three meals daily at regular and fixed hours three or four quarts of milk, according to its size and vigour. Feeding should always be sufficiently abundant, and the calf flesh never lost. Where a calf is fed from the pail, the milk may be increased from week to week for a month; the new milk may then be gradually diminished and replaced by sweet separated or skimmed milk, a small quantity of cod-liver oil (2 oz. per gallon) being mixed with the milk at each meal to provide for the loss of fat thus sustained. Many feeders, however, prefer to mix cooked linseed meal or linseed cake dust, or one of the various patent calf-meals, with the mixed milk, increasing both from time to time until the calf is weaned. In the several sets of experiments on the farm of the Yorkshire College the most economical results were achieved by feeding calves, which were subsequently sold fat to the butcher, upon milk fortified with cod-liver oil in the manner suggested. The oil is practically equivalent in feeding value to the fat of milk, while its cost averages 6d. per lb., or less than half the value of butter-fat.



TEMPORARY INCISOR TEETH



PERMANENT INCISOR TEETH

To return to the cow. While still in the box she may receive a couple of warm bran mashes daily for two or three days, being also supplied with sweet hay and lukewarm water. She should, however, be gradually placed upon the rations which are supplied to the milking cattle in general preparatory to returning her to the herd. Unless the weather is severe, she may be turned out on a genial morning for a few hours, and subsequently for a longer period, being fit within a week to join her neighbours.

Bulls. Although there are breeders who put precocious heifers to the bull at the age of eighteen months, twenty-one months is sufficiently early. The selection of the bull is of the highest importance for he represents, from the breeding point of view, more than half the herd. While each calf inherits certain characteristics from its dam, every calf in the herd inherits those of the bull employed. If the calves are bred for milk production, the bull, like the cow, should be of a heavy milking strain; if for beef, both sire and dam should come of a strain which produces stock of high quality and rapid feeding power. The cow carries her calf from 275 to 280 days—sometimes slightly longer in the case of bull-calves. The calf, which may be castrated at from four to eight weeks if in good and vigorous health, should be weaned at from five to six months. Preparatory to this event, however, it should have been accustomed, by the gradual introduction of these foods, to eat hay, which should be of the best, and rations composed of hay-chaff, chopped roots, linseed cake dust or meal, and occasionally crushed oats. It is uneconomical to turn out spring calves on to pasture land during their first year; good feeding on hand-prepared rations is followed by much better results. Cows used for breeding should never be fat, nor should they, under any circumstances, be allowed to come into contact with cows which have aborted or " cast " a calf. Abortion (which is contagious) is the greatest scourge on the stock farm. This question, however, is referred to in Dairy Farming.

Indications of Age. The age of cattle is chiefly determined by the teeth, but the horn and the general appearance are indications after a cow has passed her prime. Although the rule is by no means invariable, a somewhat imperfect ring is formed on the horn after the birth of every calf, and the horn which is heavily ringed is thus indicative of age. Cattle have 32 teeth, eight being incisors, all of which are in the lower jaw. The centre pair of permanent incisors are up at about twenty-two months; a second pair, those right and left of the centrals, at thirty months; a third pair, right and left of these at three years; and the outside, or corner pair, at three and a half years. In some instances, especially where grazing is hard or the food coarse, these teeth may appear earlier. The remaining teeth are molars, six being provided on each side of each jaw. It is generally assumed that a butcher's carcase weighs four-sevenths of the live animal; in other words, a live bullock weighing a given number of stones of 14 lb., weighs, in the carcase—*i.e.*, deprived of all offal—about the same number of stones of 8 lb. But this does not hold good in well-fatted stock. For example, the champion cross-bred heifer at Smithfield in 1905 weighed 1,247 lb., alive and 812 lb. dead. Thus the butchers carcase weighed about two-thirds, or 66 per cent., of the live animal. Much, however, depends upon the breed and the extent to which the animal has been fattened. Some breeds feed more rapidly than others, and make a larger daily gain in weight from birth to slaughter. The heaviest weights are attained by Shorthorn, Hereford, Welsh, and Sussex cattle, among the pure breeds, and by cross breeds, the last-named being quite equal in this respect to the beef varieties up to three years old. As age increases, the proportion of daily gain

AVERAGE WEIGHTS & DAILY GAINS OF CATTLE AT SMITHFIELD

BREED AND AGE OF CATTLE	Average Weight of Class in 1905.	Daily Gain from Birth. Average of 1903-4-5.	
	lb.	lb.	oz.
Shorthorn Steers, not exceeding 2 years	1,450	2	1·22
,, ,, above 2 and not exceeding 3 years	1,860	1	13·04
,, Heifers, not exceeding 3 years	1,770	1	11·13
Hereford Steers, not exceeding 2 years	1,365	2	1·94
,, ,, above 2 and not exceeding 3 years ..	1,622	1	13·19
,, Heifers, not exceeding 3 years	1,601	1	9·92
Devon Steers, not exceeding 2 years	1,229	1	11·93
,, ,, above 2 and not exceeding 3 years ..	1,678	1	9·80
,, Heifers, not exceeding 3 years	1,375	1	9·03
Aberdeen-Angus Steers, not exceeding 2 years ..	1,334	2	0·21
,, ,, ,, above 2 and not exceeding 3 years..	1,788	1	12·33
Aberdeen-Angus Heifers, not exceeding 3 years ..	1,676	1	9·26
Sussex Steers, not exceeding 2 years	1,459	2	1·49
,, ,, above 2 and not exceeding 3 years ..	1,831	1	12·29
,, Heifers, not exceeding 3 years	1,685	1	10·77
Red Poll Steers, not exceeding 2 years	2,560	1	13·70
,, ,, above 2 and not exceeding 3 years ..	1,596	1	12·90
,, Heifers, not exceeding 3 years	1,399	1	7·88
Galloway Steers, not exceeding 2 years	1,205	1	12·69
,, ,, above 2 and not exceeding 3 years ..	1,562	1	8·66
,, Heifers, not exceeding 3 years	1,390	1	5·06
Welsh Steers, not exceeding 2 years	1,432	1	12·13
,, ,, above 2 and not exceeding 3 years ..	1,787	1	10·86
,, Heifers, not exceeding 3 years	1,511	1	8·93
Highland Steers, not exceeding 3 years	1,505	1	7·34
,, Oxen, above 3 years	1,854	1	5·20
,, Heifers, not exceeding 4 years	1,466	1	1·55
Cross-bred Steers, not exceeding 2 years	1,496	2	1·78
,, ,, above 2 and not exceeding 3 years	1,884	1	12·01
,, Heifers, not exceeding 2 years	1,396	2	0·14
,, ,, above 2 and not exceeding 3 years	1,655	1	9·53
Kerry, Dexter, and Shetland Steers, not exceeding 2 years, nor 8 cwts.	735	1	4·08
Kerry, Dexter, and Shetland Steers, above 2 and not exceeding 3 years, nor 10 cwts.	1,359	0	15·53
Kerry, Dexter, and Shetland Heifers, not exceeding 3 years, nor 9 cwts.	806	0	12·05

in live weight diminishes. Thus, a Shorthorn steer may gain 2 lb., or slightly more, daily, up to two years old. At the age of three the daily gain will have diminished to 1·6 or 1·7 lb., falling again in the succeeding year. Heifers make slightly smaller gains during the same periods than steers. The highest daily gains are made by Shorthorn, Aberdeen, Hereford, Sussex, Welsh, and cross-bred cattle; and the smallest, amongst the leading varieties of beef-producing stock, by Galloways, Red Polls, Devons, and West Highlanders.

The following figures, which we have arranged on the basis of the averages of Mr. Charles Macdonald, of the "Field," give the average weights of steers and heifers for the year 1905 at our greatest fat cattle show (Smithfield), together with the average daily gains which they have made in the three years from birth. The figures are most instructive, and will enable the student of British live-stock to learn of what each breed is capable, and how far it is possible, by the acquisition of similar weights at similar ages, to realise a profit on the feeding as well as in the breeding of cattle.

As producers of milk, butter, and cheese, the non-pedigreed or dairy Shorthorn stands first among the beef producing varieties, followed by the Devon and the Red Poll. The richest milk is produced by the South Devon, but among the Shorthorns named there are many individual cattle which produce milk equal to that produced by the cattle of the Channel Islands—the Jerseys and Guernseys—these breeds being the best of all for butter production. For cheese-making purposes no breeds are superior to the dairy Shorthorn and the Ayrshire. The Hereford, the Sussex, the Aberdeen, the Galloway, and the West Highlander may be excluded altogether from milk, butter, or cheese-producing stock.

Continued

THE MIDDLE AGES

The Development of Christianity. The Birth of States. England under Seven Monarchies. The Danes. Mahomet and his Teaching

By JUSTIN McCARTHY

OUR course now brings us to the history of those centuries known as the Middle Ages. The interval of time thus described comprehends the period between the decline of one form of civilisation and the coming into distinct operation of another. The two events which mark most conspicuously the opening and close of that interval are the removal from Rome of the seat of the Roman Empire and the capture of Constantinople by the Ottoman Turks.

Christianity in Europe. In the meantime many of the peoples regarded by the Romans as barbaric, some of whom had kept them in constant warlike movement by their reprisals and invasions, had been growing into powerful and more or less civilised States.

Formed for the most part on the foundation of common nationality, these States had been growing into a civilisation of their own. Among these were the kingdoms of Gaul and Spain, the Saxon kingdoms in England, the Franks, the Germans, the Danes, the Saracens, the Hungarians, and the Moors. Most of these races were European and Christian, but some of them, as their names indicate, came from the East and had not yet accepted the light of Christianity.

During this period the Christian religion had established its central seat in Rome. The conversion of Constantine to Christianity had contributed emphatically towards the recognition of Rome as the home of the Papal authority, and the Papal authority represented for many centuries the Christian religion. The Popes exercised much political and territorial influence even while the Roman Empire still claimed supreme authority from its new seat in Constantinople.

The Barbaric Races. It soon became evident that some of the races which the Rome of the Emperors had persisted in regarding as barbaric were destined to compete for the leading part in the world's civilisation. England, France, Germany, and Spain were already sending before them the beacon lights of their progress. Some of these peoples were for a time divided among themselves, and even claimed to have a distinction of race which they strove to maintain; but their gradual movement proved to be toward amalgamation and cohesion, prompted and made necessary by the demarcation of the regions in which they lived and about which they often contended, and prompted also by a common national instinct. The outer barbaric world, which was still Pagan, kept up a constant religious strife with the peoples who had accepted Christianity, and the Christians themselves were not slow in their endeavour to spread by arms their power over the barbaric regions.

The Birth of States. The peculiarity of this period of the world's growth was the fact that the wars were mainly carried on with the object of spreading a religious faith or resisting its advance. The Huns, the Visigoths, the Vandals, and other powerful races were spreading their influence widely over Europe. Alaric and his Visigoths captured Rome in the early part of the fifth century, and Attila and his Huns overran Italy and a great part of France. These invasions, while they destroyed much, did not succeed in creating anything, and the real history of the Middle Ages was made for the most part by the European races who were striving to form themselves into separate and cohesive States. The Gauls or French, the Germans, and the Saxons, to whom the kingdom of Great Britain owes its distinctive growth, were beginning to settle down into separate States representing different nationalities. The inhabitants of Great Britain had much keen strife among themselves before this could be brought about, and the strife would probably have lasted longer still were it not that the seas separating the island from the European Continent suggested to the islanders thus defended by nature the advantage of forming themselves into one consolidated State.

The Three Races of Britain. Britain was, until the opening of the Middle Ages, peopled by at least three distinct races. These were the Saxons, the Cambrians or inhabitants of Wales, and the Caledonians or inhabitants of Scotland, who were themselves divided into Picts and Scots. The Saxons came originally from the northern part of Germany, and had established themselves by invasion and conquest, and their settlement in England had brought many Scandinavian incursions. Two famous Saxon chiefs, Hengist and Horsa, brothers, are believed to have led the first band of Saxon invaders to Britain. According to historical record, these brothers were invited by Vortigern, a British prince, to come to Britain to help him against the Picts or Scots who were harassing him by frequent invasions. They readily accepted the invitation, and are said to have become allied with him in another sense by his marriage with Rowena, the daughter of Hengist. The allies succeeded for a time in defeating the Picts and were given the isle of Thanet as a reward. The alliance did not last long, for Hengist and Horsa afterwards turned against Vortigern and were defeated. Horsa was killed in this encounter, but Hengist is said to have remained in possession of Thanet and to have become ruler of the whole region which we now know as the county of Kent. He bore for some time before his death the title of King of Kent.

Seven Monarchies in England. As usually happens under such conditions, the Saxon settlers or invaders were disposed to enlarge as far as possible the region of their settlements and to maintain a perpetual dominion over it. By them was founded the kingdom of Sussex or South Saxons, that of Wessex or West Saxons, and that of Essex or East Saxons. Another race, the Angles, founded kingdoms in Northumberland, on the eastern British coast, and there were no less than seven separate monarchies in England at one time. These were described by historians as the Anglo-Saxon heptarchy and gradually became blended into one united State. The Saxons were the most widely spread and most enduring, and to them Englishmen mainly owe their language except for that very considerable part of it which is taken from the languages of Greece and Rome.

The Franks made for themselves a place of the highest importance in history. They were a people of Germanic origin and were a sort of federation of Germanic tribes between the Rhine and the Hartz Mountains, while the Alemanni occupied the upper banks of the river. The original meaning of the word Frank appears to have been "free man," and the name was given to those German combinations just mentioned, which undertook the invasion of many other parts of Germany, and overran a great part of Gaul. The country of the Gauls, or Gallia, as it was called in classic days, comprised the whole of France and Belgium. The Gauls had made themselves conspicuous during the existence of the Roman Empire, and after the fall of that Empire they succeeded in establishing a kingdom in France, and France succeeded through many tumultuous centuries of war in establishing herself as one of the recognised nationalities and recognised Powers of Europe. During these years the Germans, too, were forming themselves into a distinct nationality and Power.

Races in Search of Homes. The Northmen—Danes—made a temporary settlement in England, and it would seem to one who glances over the history of those centuries as if the people of Europe had not yet decided where their homes ought to be, or even as to the regions from which they had descended.

The various tribes and races would appear to have been each in quest of its ancestral and actual home, and to have conducted its invading enterprises with the hope that, by penetrating successively into each territory, it must at last reach that particular land from which its forefathers had come. It is certain that some of these enterprises were not undertaken with the mere desire to plunder weaker tribes, or even with the ambition for territorial conquest, but that many of the invading races were inflamed with something of a half poetic, half religious passion for a re-discovery of their ancestral home and a permanent settlement in it. Such a feeling might be explained in great measure by the fact that so many of those peoples had in their early days been driven out of their own country by the invasion of conquering races, or had themselves taken possession of regions foreign to them, and had had to maintain that possession by generations of war and incessant strife, finding themselves at last becoming less and less suited to the climate and the other conditions of the territory which their ancestors had captured.

Rise of European Powers. There became thus gradually established in Europe several distinct nationalities or States recognising themselves as such and demanding a like recognition from their neighbours. These States were England, France, Spain, Italy, Germany, Russia and Turkey. There were also other distinct nationalities such as the Scandinavian peoples in the North of Europe, the Hungarians, and the Greeks. The Ottomans remained during all manner of changes, and were then, as they still are, an Oriental settlement on the soil of Europe. The history of Ireland had for a long time little or no association with that of England, and the earliest records of Ireland's story show that the Irish always claimed for themselves an origin entirely different from that of the neighbouring and larger island. We shall deal with the history of these various nationalities as we follow their course. For the present our object is to show how the populations which had grown up in Europe, or had come into Europe by invasion, began to form themselves into separate States.

So far as the Eastern world was concerned, the great wall of separation between Europe and the Oriental peoples, even between the rest of Europe and the one Oriental people holding position as a European State, was raised by the spreading influence of Christianity. Already the European world was divided by religious faith into Christians, Jews, and Mohammedans—the latest traces of Paganism may be said to have disappeared. The religious difference between the Christians and the Jews did not tend to prevent the recognition of a common citizenship in many or most communities. The Jewish converts to Christianity were daily increasing, while no conversion of Christians to Judaism showed itself anywhere to any extent worth noting. Thus the growing kingdoms and empires of Europe proclaimed themselves Christian, and there was even already a degree of vitality, and an amount of solidity in them, which marked them out distinctly as enduring component parts of the world's system.

The Great Cities. Some of the great centres of modern civilisation were already beginning to claim recognition. London, the capital of the British Empire, had been occupied by the Romans, and is described by Tacitus in the first century as a prosperous trading city. He writes of it as Londineum, a name which is understood to have been not Roman but Celtic, and to have meant the gate or fortress of a lake or river. Paris was called Lutetia while the Roman Empire still prevailed, and during the time of Julius Cæsar that name applied to the rising town or settlement on the Seine of the Parisii, a Gallic tribe conquered by the Romans. Lutetia in the fourth century A.D. became known as Parisia or Paris, and two centuries later under Clovis it

became the capital of the whole country and a Royal residence. Many of the other European capitals came into established recognition at a later date. But the division of Europe into States with recognised frontiers and limitations was almost entirely the work of the Middle Ages. Although many modifications, separations, and reuniting of populations have since taken place, yet the boundary lines on the whole seem to have been traced out and settled during that eventful period. Feudalism had its beginning in the Middle Ages, and so had that system of religious chivalry to which we owe the Crusades.

Eastern Nations and Christianity. The spread of Christianity and the growth of so many European States roused the Eastern world into anxiety and alarm as to the growth of this new power which Eastern kingdoms were already beginning to regard as a danger threatening their own existence. The Roman Empire had already invaded the East and settled itself in Constantinople. The Eastern nations naturally failed to understand that this change foreboded the decay and not the increase of Rome's power, and the establishment of the Roman capital in a region bordering so closely upon Asia was regarded as a warning that a coming invasion of the East, not merely by a conquering European race but by a religion which had already conquered Europe, was one of the events of the near future. The dread of such a prodigy led the minds of Arabians and of other Eastern races to doubt whether the faith which they and all their ancestors had professed was that securely established form of creed which the Divine Overruling Power had destined to be eternal. It was a time of revolution, and we all know that such a period is ever sure to bring to the front some daring and self-inspired propounders of new principles and leaders of new enterprises. Arabia was especially a country in which such phenomena might be looked for. Its people were intelligent and thoughtful, and they had had much intercourse with Europeans forced upon them by frequent visits of travellers and even of invaders from the Western world. They were not wrapt up wholly in that reverence for ancestral and for settled forms which was a characteristic of other Eastern races—the Chinese, for instance. The course of events illustrates our meaning.

Arabia. One of the greatest changes made in the world's history during the period following the fall of the Roman Empire had its origin and its workings in Arabia. The country which was destined to play so important a part in history was, during the greater days of the Roman Empire, but vaguely known to civilisation, and was assumed to be little better than a vast desert. It is an immense peninsula which spreads northwards into Asia. The geographers of the Roman world divided it into three parts: Arabia Petraea, Arabia Deserta, and Arabia Felix. Its earliest religion, so far as it can be traced, was a sort of idolatry, a worship of vague divinities springing from the almost universal belief in some supernatural ruling power, a belief congenial with the Arabian mind, which was naturally poetic and could not limit itself to an acceptance of the material world which it saw every day, but had to create for itself some form of faith independent of and above the world around. More lately some of the Arab peoples had been touched by the spirit of Christianity, while others had been attracted by the teaching of the Jews who were then penetrating the country from all sides, and large masses of the population had gone no farther in their religious belief than to acknowledge the worship of Allah, whom they regarded as the Supreme Being, and with whose worship they associated many forms of idolatry.

Mahomet. There arose at this time the man who was destined to found a faith and a powerful dominion, both of which were to exercise a long-enduring influence throughout the whole of the Eastern world. This man was Mohammed, or, as he is now usually called by English writers, Mahomet. Mahomet was born in Mecca about the year 570, A.D., and was the son of a merchant who was very poor, although belonging to one of the powerful tribes into which the country was divided. His father died very soon after Mahomet's birth, and his mother passed away while he was still a child. The little boy was taken in charge by an uncle, and obtained his living for a while mainly by tending sheep. Then he took to camel driving, and travelled largely through Syria. He proved to be a young man of remarkable intelligence, and his mind became filled with a fixed idea—the rescue of the faith of Abraham from what he believed to be its perversion by the Jews. To this purpose it became his unconquerable ambition to give himself wholly up. Fortune is proverbially said to favour the brave, and fortune favoured Mahomet at this critical moment in his career. A rich widow named Khadijah, some twenty years older than he, and destined to be known to all history because of him, fell in love with the young man and left him free to give up the work of making a living, and to follow out his own path of inquiry and aspiration. His wife is believed to have enjoyed his full confidence in the great project which he had now set out for himself, and to have helped him by her counsels and her encouragement. Then came the dreams of the self-absorbed fanatic, a sincere fanatic and a dreamer who reverenced his dreams as realities.

The Koran. Mahomet made known to his wife and to his confidential friends that he had received from the Divine Power, through the angel Gabriel, a message embodying the contents of a book which was to be the religious instructor of the human race. The book was called Alkoran, or the Koran, "Al" being the Arabian version of the article "the," and Koran signifying emphatically a book that must be read. Mahomet described the religion, which was to be authorised by this book, as Islam, a word signifying obedience to the Divine commands. There must have been something inspiring in the nature and the character of the man which won on those who listened to him, for from the very first his wife

and his friends regarded him as one endowed with a mission to proclaim a new doctrine. His believers and followers increased day by day, and before long seemed to the State authorities to be a danger to the faith of the people and even to the safety of the country. Mahomet soon found that his life was in peril, and he fled to Yathreb, afterwards known as Medina. The time of his flight, the year 622, dates among the Mussulmans as the Hejira—the flight of the Prophet from the region which would not accept him.

Mahomet communicated the text of the Koran by word of mouth to his followers, and they took down his utterances on palm leaves or on pieces of leather when they could not find better material for their records. Mahomet himself did not write down his revelations, and, indeed, made it his boast that he was absolutely illiterate, and that he was guided by inspiration and not by education. The book was afterwards put into shape, and revised, and modified under the reign of successive Mohammedan caliphs; but in its main purpose it remained unaltered as a code of religious, moral, civil, and even political teaching, suited, as if by instinct, to the character and temperament of the Eastern populations over whom it was to have so large an influence. The teaching of the Koran, when considered in its purely spiritual sense, may be summed up in the dogma, "There is no God but God, and Mahomet is His Prophet." The book differs essentially from the creeds prevailing in the days of Greece and Rome and before the Christian era, for it shut out altogether any recognition of the existence of a variety of deities, each presiding over and directing some part of man's nature and life.

Mahomet's Teaching. Mahomet preached as his doctrine the immortality of the soul, the resurrection of the body, and the rewards and punishments allotted in the future life. He admitted that Christ had worked miracles and did not claim for himself any such power, but he maintained that he bore the latest message from Heaven, and that humanity must accept and obey his teachings. The Koran condemns most of the acts and practices which the Bible regards as criminal; and it is very strict and minute as to prayers, fasts, and sacred days and the annual pilgrimage to Mecca, which Mahomet had appointed as the central home of the new worship. He displayed a certain degree of toleration towards Christians and Jews, and while advising his people not to enter into marriage relations with those who professed the creed of Christ or that of Abraham, he declared it not lawful to make war upon them unless when they themselves had begun the attack and thus made resistance needful. But as regards all races who did not profess to follow the teachings of Christ or those of Abraham, he held that it was the duty and the right of all true believers to pursue them and to crush them, unless they would accept and practise the doctrines taught by the Koran.

Ruler of Arabia. By this time Mahomet had grown to be a great ruler and a great political power. He had for many years been merely an itinerant preacher of his new faith; he had lost his devoted wife, and, having spent much of the money she had brought him on the spread of his religious teachings, had been more than once reduced to poverty. But Mahomet was not a man to be turned from the course he had marked out for himself. He continued to increase the number of his proselytes, and struggled fiercely at the head of his followers against all sects which opposed him; he became a great military chief, and he captured Mecca. He was recognised, in fact, not only as the Prophet, but as the ruler of Arabia. His career brought about one of the greatest revolutions known to history, and for a time his was the one absolutely commanding figure among Eastern peoples who had been converted to his doctrine. It may seem to European students hard to understand how a man so little favoured in any sense by fortune at the opening of his career should have created for himself so wide-spreading and so enduring a domination. He was not born to greatness, he does not seem to have had the intellectual gifts of a Julius Cæsar, and, although he claimed to be a religious prophet, he did not conquer his world by religious teaching alone, but had recourse to the warlike arts of the ordinary conqueror—arts for which he had had no special training. His career is not to be explained by any of the explanations which serve to illustrate the careers of others who made themselves masters of peoples and founded new systems of government. We have to take him as we find him, and to regard his success as one of the most marvellous prodigies of the Middle Ages. During his last pilgrimage to Mecca he proclaimed on Mount Ararat the ceremonials of the pilgrimage as they were to be for all future years.

Mahomet's Death. His death was peaceful, and came to pass shortly after this last pilgrimage. He fell ill soon after his return to his home, and never recovered. So long as his sinking strength would allow him, he took part in the public prayers. He died early in the June of 632. His character unquestionably had many great defects. He was sensuous in peace, unrelenting in war, and unsparing in his punishment of those who offended against him. But it is only fair to say that these were defects peculiarly characteristic of the times he lived in and the country in which he was brought up; and that the new faith he sent forth did not even profess to be a creed which preached and pleaded for purity of private life and mercy towards conquered enemies. It is impossible not to feel that there must have been an intense sincerity in his nature, that he must have been convinced that he was charged with a sacred mission, and that in following out his career he was not governed by any passion for personal aggrandisement or by the selfish desire to become a ruler of men.

Continued

SYSTEMS OF SUPPLY

Direct and Indirect Supply. Two-wire and Three-wire Systems. Motor Generators and Converters. Feeders and Boosters

By Professor SILVANUS P. THOMPSON

ELECTRIC energy is supplied to the public on several different systems. Since the lamps and motors which are adapted to work on one of these systems are not always suitable to work on another system, it is important that the peculiarities and properties of the different systems should be understood. Also, it is necessary that the meanings of the terms used in describing their arrangements should be made quite clear. The term *system* is itself used in two different ways to mean (1) in general the collection of machinery and distributing mains that supply the current, as, for example, when one says that the Hampstead system supplies 60,000 lamps; (2) in a technical sense to distinguish between one electrical method of supply and another method, as when one speaks of a *three-wire* system or of a *high-voltage* system. It is in this technical sense that we use it in this section.

Methods of Supply. All methods of supply may be divided under two headings—namely, *direct* and *indirect.* In the former, the current is supplied to the consumer at the same voltage at which it is generated at the station, there being a *direct* electrical connection of metallic wires between the two. The indirect methods are used when the supply area becomes so large that it is no longer economical to generate at the same voltage at which the current is supplied to the lamps and motors in the consumers' houses. Such methods of supply divide the system up into two parts—namely, a high-voltage part used for transmitting the electrical energy, and a low-voltage part for distributing it. So the supply of current is *indirect* in that there is no direct electrical connection between the generators and the lamps, motors, or other devices for utilising the supply.

Classification. Classifying the various systems under these two main headings, we have the following table:

DIRECT METHODS	INDIRECT METHODS
Series Distribution	Transformers to step down at sub-stations
Parallel Distribution—	Transformers at generating station to step up, and at sub-stations to step down
(a) Two-wire	Motor-generators in sub-stations
(b) Three-wire	Converters in sub-stations
Series-parallel Distribution	

Series Distribution. An early way of distributing current to arc lamps was to join them all in series, as indicated diagrammatically in 157. In such a case the same current goes through all the lamps, and as it must be maintained of invariable strength, the system is also called the *constant-current* system. When this system was in use, one dynamo was designed to give the current to, say, 40 lamps in one series. As each needed about 10 amperes at 50 volts, the arc-lighting dynamo for that circuit was required to generate a 10-ampere current at 2,000 volts. In order to extinguish any one lamp, it had to be short circuited, otherwise the rest of the lamps in that series would have gone out also. Had these 40 arc lamps been arranged in parallel the dynamo would have had to work at about 60 volts—allowing a 10-volt drop—and would have had to furnish 400 amperes to the mains, which must therefore have been of very thick copper; whereas, if joined in series, the wire need only be thick enough to carry 10 amperes. Hence the series system lent itself to cases where arc lamps were wanted at long distances apart, with overhead wires. But where there is a regular distributing supply in a town, it is not worth while to put up a separate series system for lighting the streets.

Parallel Distribution. This is shown in diagram in 158. The lamps are connected individually across the mains by wires which connect across from positive to negative, being thus electrically in *parallel* with one another. The fraction of current which passes through any lamp passes through that one only, and then goes to the return main. Hence the two distributing mains have to be thick enough to carry the sum of all the separate small currents going to the individual lamps. Suppose that in a building wired on this plan there are eight arc lamps taking 10 amperes each, 400 glow lamps of 16-candle power taking 0·5 amperes each, and 50 other glow lamps of 32-candle power taking 1 ampere each, then the total current will be $(8 \times 10) + (400 \times 0{\cdot}5) + (50 \times 1) = 330$ amperes; and the mains supplying that building must be thick enough to carry that quantity of current.

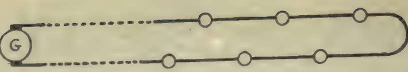
When this simple arrangement is adopted, it is sometimes described as a *two-wire* system, and as the same voltage is always required on every one of the lamps that are connected to these mains, the dynamos must be designed to supply the mains with an unvarying voltage.

Formerly, the two-wire systems in English towns were supplied as 100 volts, and the lamps were made so as to give their proper brightness at that pressure. In recent years the supply is more often given at 200 volts, and the lamps have to be made with filaments that are both longer and thinner, and are consequently more fragile. At the double voltage they take, of course, only half as much current to give the same light; but they consume, of course, the same number of watts. The advantage is in the saving of the cost of copper in the mains, which

may be made, for an equal total energy supplied, of one quarter the weight. Whatever the voltage of the two-wire mains, the method is a *constant voltage* system.

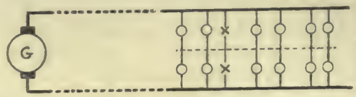
Series Parallel Distribution. Before the makers had found out how to make lamps suitable for 200 volts, a plan of working with 200-volt mains was adopted as shown in **159**, in which two 100-volt lamps were joined in series with one another, and connected across the mains. This plan has the disadvantage that if one lamp goes out the other goes out also. It was proposed to remedy this by cross-connecting the rows of lamps with a middle wire (shown dotted in **159**); but this is not satisfactory unless the middle wire can itself be kept at an exact intermediate voltage. The plan of putting several lamps in series into each parallel branch across the mains is used in certain cases when the distribution is at a high voltage; for example, on some of the electric railways that are worked at 500 volts it is customary to light the carriages with 100-volt lamps, five of which are connected in series and fed at 500 volts.

Voltage Drop. Whenever current is sent through a long conductor, part of the electromotive force is spent on driving the current through the resistance of that conductor. Hence, in supplying current to lamps through a pair of mains, there will be a voltage drop, and the lamps will receive a voltage lower than that of the generator. The amount of the voltage drop is readily calculated in any given case by applying Ohm's law [page 671], by merely multiplying together the number of ohms of resistance by the number of amperes of current flowing through that resistance. Suppose

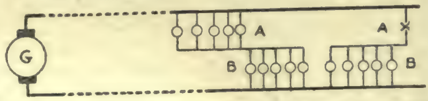


157. SIMPLE SERIES CIRCUIT

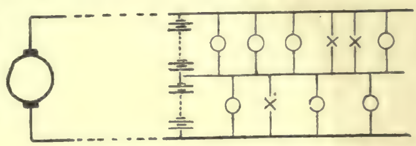
158. SIMPLE PARALLEL CIRCUIT: TWO-WIRE



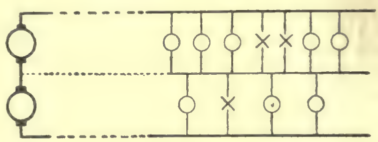
159. TWO-WIRE: TWO LAMPS IN SERIES



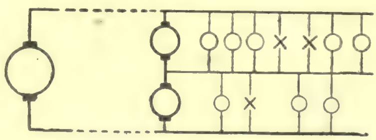
160. TWO-WIRE: BANKS OF LAMPS IN SERIES



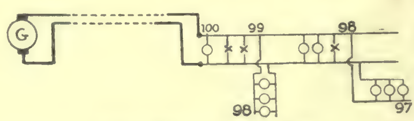
161. THREE-WIRE, WITH BATTERY



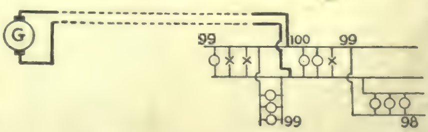
162. THREE-WIRE, WITH TWO DYNAMOS



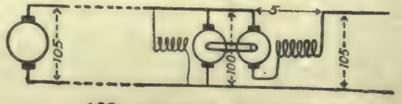
163. THREE-WIRE, WITH BALANCER



164. FEEDER DIAGRAM



165. FEEDER DIAGRAM



166. DIAGRAM OF BOOSTER

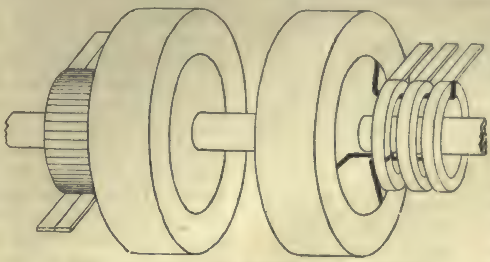
a current of 80 amperes to be supplied to a house 100 yd. from the dynamo, through a pair of mains made of stranded copper of the size known as 37-18's. These mains—that is, the going main and the return main—will together offer 0·0875 ohms resistance, and when the full current is on through them the drop will be $80 \times 0{\cdot}0875 = 7$ volts. If, then, the dynamo were to generate its current at 100 volts, the lamps would get only 93. Or, to give the lamps their proper voltage, the dynamo ought to be so compounded [page 1324] that at full load its electromotive force rises to at least 107 volts. In all distributing and transmission mains voltage drops occur, and must be taken into account in the calculations.

Three-wire System. When lamps at 100 volts were appropriate for use in private houses, the supply companies sought to gain the economic advantage that arises from the use of a double voltage by making the connections shown in **160**, where the set of lamps A may represent those in one consumer's house, or in one side of a street, and the set B represent those in another house or in the other side of the street. In this way there is a voltage of 100 only in either A's house or in B's house; yet it is 200 volts between the two outer mains. The disadvantage of such a plan, if this were all, is that the number of lamps which A has alight at one time may not be the same as that which B has alight at the same time; and since the total current going through the two sets is necessarily the same, if A has more lamps going than B has, A's lamps will not get enough current, and will look dull, while B's lamps will get more current than they should, will be over-bright, and will be soon spoiled.

Further, in consequence of the inequality in the number of lamps on the two sides, the central connection, or middle wire, will not be at a voltage midway between the voltages of the two outer mains. In this statement lies the solution of the problem. If we can keep this middle wire at a voltage midway between the voltages of the outer mains every lamp will get its proper voltage, and take its proper current, irrespective of the number that may be alight on each half of the system.

Modes of Balancing. An arrangement to solve this problem is indicated in **161**. A battery of accumulators is connected across the outer mains, and the middle wire of the distribution system is connected to the middle of the battery. In laying out an electric lighting scheme on the three-wire plan, the engineer makes a judicious selection of the streets or districts which are to be connected up to one side or other of the middle wire, choosing them so as to ensure as nearly as possible equal demand for current in both halves. Then the amount of *out-of-balance* current (or difference between the amperes demanded on the A side and on the B side) will flow to or from the battery along the middle wire; and if his choice has been judicious, this in-and-out flow will be relatively small. The battery, in fact, has to supply the balance of current between the two sides of the system, and the middle wire may be thinner than either of the outer mains. The battery may be placed either in the generating station or at some convenient spot nearer the centre of the actual points of distribution.

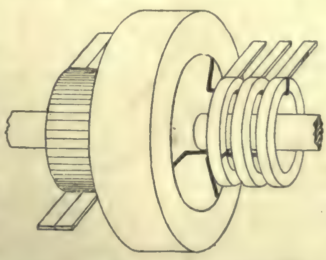
Figs. **162** and **163** show other arrangements of the three-wire system, for the balance between the two sides may be maintained by other means than by batteries. In **162** we have two similar dynamos, which may both be seen on the same engine, and which are connected electrically in series with one another, with the resulting voltages as marked on the diagram. In **163** we have an arrangement which is equivalent to a battery at a distant part of the mains, and which consists of two identical shunt motors, the armatures of which are connected in series with one another across the mains. Their field-magnet coils must be suitably cross-connected. This combination is called a *balancer*. Its action is as follows. Normally, both machines run as motors doing no work, generating back electromotive forces [see page 1593], practically equal to those of the mains. If, however, owing to the consumer's lamps on one side (say, A) of the system being more numerous than those on the other side, the voltage between outer and middle will fall a little at one side and rise a little at the other. Immediately, one of the two motors will automatically begin to work as a motor, and give power to the other one, which then works at a higher electromotive force, and begins to generate current and pump it into the side where the demand for current is greater. It thus preserves the balance, and keeps the middle point at a mean voltage.



167. DIAGRAM OF MOTOR-GENERATOR

Feeders. In a network of cables used for supplying a town from a central power-house, the cables may be considered as of two kinds — namely, (1) *feeding* cables, which go straight from the station to local centres without any intermediate branching; and (2) *distributing* cables, which start where the feeding cables end, and from which are tapped off at many points, wherever necessary to supply another street or a fresh customer, the smaller branch-mains. To minimise the voltage-drop between the power-house and the farthest consumer, the feeding cables are brought to the distribution network at a point selected so as to be as central as possible. This point is quickly made evident by reference to **164** and **165**. In these figures the thick lines represent the feeder cables, which in this case are allowed to produce a drop of five volts by the time the feeding points are reached. In **164** the feeders are connected to the nearest end of the local network, and the voltage-drops are indicated, the greatest drop being at the farthest end, where the 100 volts drops to 96. In **165** the feeders are brought to a central point in the local network; and it will be seen that the voltage drop at the distant end of the network is thereby much reduced.

Boosters. In some cases the drop of volts in the feeder cables, shown above as 5 per cent., becomes a serious item. The drop is not the same for all loads, for it is proportional to the current [see Ohm's Law, page 670, etc.], so that in the daytime, or late at night, when very little current is being taken, practically the full voltage of the station (assumed here at 105 volts) is across the distant lamps, which will then burn over-bright; while during the period of full-load in the evening there will be a voltage of 98 or 99 only for these lamps, and they will run dull. Such a wide variation is not desirable, for incandescent lamps are sensitive to changes in the voltage. Hence, there has arisen a practice of compensating the voltage-drop by means of a piece of apparatus known as a *booster*, which is used either at the station or at the network end of the feeders, to raise or "boost-up" the voltage



168. DIAGRAM OF CONVERTER

little by little as the feeder becomes loaded. Fig. **166** is a diagram of a booster, and shows that it consists essentially of a shunt-wound motor, M, driving a series-wound generator. The motor, runs at a constant speed, while the current which flows through the armature and field-coils of the generator is the current which is being supplied through the feeder to the network, so that the amount of magnetism in the field-magnets of the generator depends on the current that is being supplied; hence also the voltage added by the generator part is proportional to the load on the feeder. Other methods of exciting the booster are obviously possible.

Indirect Methods of Supply. The first two of the methods noted under this heading at the beginning of this article are used both in continuous current and alternating current working. The necessity for these indirect methods has already been explained, and it is sufficient to mention that they are carried out with continuous currents by the use of motor generators, the motor receiving current at one voltage, and the generator being wound for a different voltage, higher or lower, according to whether we are considering the central or the sub-station end of the transmission line. With alternating current the conversion is much simpler because we can use transformers [page 1657], in which there are no moving parts, and which can, therefore, be installed once and for all in a manhole or in a street pillar and require no further attention.

The third method noted is used on continuous current, as described above, but it and the fourth method are used more particularly in places where alternating current is used for transmission and continuous current for distribution. A motor-generator for this purpose would consist necessarily of an alternating current motor coupled on the same shaft to a continuous current generator of equal capacity, and the electrical energy would be first turned into mechanical energy by the A.C. motor, and then this mechancal energy is converted into electrical energy by the C.C. dynamo. This arrangement is not the most compact, for with alternating currents it is possible to combine the motor and generator in one machine, called a *converter* or *rotatory converter*, thus enabling the efficiency of the transformation to be increased.

Converter. Referring to **59** [page 1106] and to **79** [page 1358], we see two revolving type armatures, the former being used for continuous and the latter for alternating current. Now, both these armatures might have been fitted with a commutator, and would equally well have given continuous current, or, on the other hand, both might have been fitted with slip-rings, and they would have been equally suitable for supplying alternating current, either single or polyphase. From this it is obvious that one of these armatures could be fitted with a commutator at one end and slip-rings at the other. We could then draw both continuous and alternating current from it. Such a dynamo is called a *double-current* machine, and the current which flows in the armature conductors is the sum of the continuous and alternating currents which leave at either side, and the total copper losses in such an armature would be the same as would occur in separate A.C. and C.C. armatures each carrying the same respective currents.

If, however, having got the machine running at the correct speed, we supply current to one side, say, the slip-rings, and draw current from the commutator, we shall have the *converter*, for the alternating current in passing through the machine will have been converted into continuous current, and the current in the armature will now be the difference between the alternating current supplied and the continuous current drawn from the machine. Figs. **167** and **168** show this evolution of the rotatory converter diagrammatically. In **167** we have two similar armatures mounted upon the same shaft, one acting as an alternating current motor, and the other as a continuous current generator. In **168** we have the two armatures superimposed upon one another, with the result that both the copper and iron losses are reduced to about half, and the cost of the converting machine will also be greatly reduced.

Converter Voltages. It is to be noticed, however, that the rotatory converter cannot receive alternating current at the high voltage of transmission. On pages 1324 and 1358 we have given formulæ for calculating the voltages generated in C.C. and A.C. armatures, and, comparing the two, we see that the C.C. and A.C. voltage which will be induced in the same armature is not the same, and for this reason, if we wish to obtain currents from a converter at, say, 500 volts, we have to adjust the voltage at which the alternating current is supplied to about 350—in the case of three-phase working.

Converters versus Motor Generators. As the alternating voltage has to be made suitable to the continuous voltage required on the converter, we see that, for use with high voltage transmission, alternating current transformers are necessary to reduce the voltage from, say, 6,600, the voltage of transmission, to 350, the voltage required for conversion, and their cost and the losses in them have to be reckoned in with those of the converters when making calculations for the whole plant. If motor-generators be used, the high alternating voltage may be used direct on the motor. But here we have two machines, with an extra cost and higher losses than we have with one, so that, taking all things into consideration, it is generally found that of the two types of converting equipment the converter with its necessary step-down transformers is the better.

The general character of rotatory converter armature, compared with the ordinary dynamo armature, is that the commutator and slip-rings are excessively large compared with the size of the core body, because of the larger current they have to carry.

Continued

FIRST CLASS CLERKSHIPS

General Conditions of Civil Service Appointments. Details of Emoluments, and Conditions of Entry. The Examinations. Class I. Clerkships

NATIONAL SERVICE continued from page 2161

By ERNEST A. CARR

Our Conspectus and its Purpose. The schedule appearing on page 2252 summarises for convenient reference the leading features of each general grade of appointment in the national service. It thus affords, as it were, a bird's-eye view of the whole subject that should prove useful to prospective candidates who are uncertain by which of the many avenues of approach they should seek to enter State employment.

In this and succeeding chapters the main outlines furnished by the table will be amplified with full particulars respecting each of the appointments in turn. The educational level of the examinations, for example, will be more exactly defined by a list of subjects and marks. Meantime, the table itself calls for a few words of comment.

First, then, as to the salaries given in Column 5. These are by no means to be regarded as representing the *possibilities* of each class. In almost every instance, ability and good fortune may secure a maximum well in advance of the figures shown. Our aim has been to show, not the utmost salary within the reach of individuals, but the amount which, having regard to the constitution of the staff and the conditions of engagement, may fairly and reasonably be anticipated without special promotion or unusually rapid rise in grade.

A Word of Caution. On this matter of salaries the representations of certain Civil Service "coaches" must be taken with a grain of salt. Anxious, for their own ends, to attract candidates to the service, they contrive, while avoiding any definitely false statement, to convey utterly wrong impressions as to its prospects. Assistantships of Excise, for instance, are announced under the headings £85 to £800. How should the raw novice guess that of an Excise staff numbering some 3,500 members, only a couple of dozen officers are receiving as much as £800 a year? The average prospects of Excise officers are more accurately represented by the figures shown in our schedule.

It should be noted that examinations in this service are dependent on the fluctuating needs of its various departments, and therefore are held for the most part at irregular intervals, as well as for a varying number of appointments. In some instances there may be a year or more between the competitions; but those by which the ranks are mainly recruited occur, as a rule, twice or thrice yearly. Columns 6 and 7 of the table furnish useful indications of the number of vacancies to be expected in each grade, and the severity with which they are contested.

A further feature calling for notice is the classification of posts according as they relate to particular offices or to the general clerical staff. Members of the latter are employed indifferently in all the larger departments. A successful competitor for a Second Division clerkship, for example, may find himself appointed to any one of about 60 Government offices, variously situated in London, Edinburgh, or Dublin, and offering very different duties and prospects. The wishes of each candidate, it is true, are consulted as far as practicable, but those who are lowest on the list necessarily receive the appointments that their better-placed rivals have passed over.

Nationality of Candidates. For posts in the national service it is essential, as already mentioned, that candidates should be "natural-born British subjects." This definition includes any person born in his Majesty's dominions, even though his or her parents may both have been lawful subjects of a foreign state. Concerning naturalised aliens and candidates born abroad, the following announcement is made by the responsible department: "A person born in a foreign country who can prove that his father or his paternal grandfather was born in British dominions is, if he has not expatriated himself under the Naturalisation Act of 1870, admissible as a natural-born British subject to all open competitions which he is in other respects qualified to enter, except those for Student Interpreterships. For these he needs the permission of the Foreign Secretary. Naturalised aliens are admissible to compete for Home Civil Service appointments."

"Wrinkles" for Students. Apart from a few special requirements of the Civil Service Commissioners, to be explained hereafter as occasion arises, the whole range of study requisite for the various examinations is covered by the courses of instruction given in the SELF-EDUCATOR. The consideration of examination subjects need not therefore detain us now. But before passing to a detailed discussion of the several grades of appointment, space may be found for a few general hints—the outcome of personal experience—on preparing for these competitions.

It is essential, in the first place, to realise that they *are* competitions, and that the task awaiting the candidate is not merely to do well in the subjects prescribed, but to do better than the great majority of his rivals. A single mark more or less may mean success or failure, and as the time allowed for Civil Service examination papers is seldom really adequate, the student must acquire by constant practice the habit of

expressing himself tersely, pithily, and to the point. In the actual contest this training will enable him to deal with as much of each paper as his knowledge of its subject-matter allows, and thus to secure as many marks for it as possible. Neglect of such a precaution leads candidates into wordy, tedious replies, unfinished papers, and, as a result, a distressing because needless loss of marks.

For the same reason, a speedy, neat, legible hand must be cultivated; and since handwriting is frequently an examination subject in itself, carrying high marks, the particular style of penmanship preferred by the Commissioners should be adopted. This is a clear, running hand, slightly sloped, and wholly free from flourishes, with rounded curves, small capitals, and short loops and tails to the letters.

The Value of Past Papers. An immense amount of effort is uselessly expended by Civil Service students every year for lack of a perfectly simple precaution. They fail to ascertain the precise scope of the examination for which they are preparing, and consequently either waste precious time over features of their work to which examiners attach no importance, or else discover in the examination room that they have underestimated the knowledge expected of them. Either error might have been avoided by a careful study of the papers set in prior contests of the same nature. Indeed, it is difficult to overestimate the advantages of that course. By a comparison of several sets of old papers the character of the test can be gauged to a nicety, and the work of preparation greatly simplified. The question tests may also be employed for the purpose of "practice examinations"—carried out, as far as possible, under actual conditions, and with special regard for the time officially allotted for each paper. In this way, as in no other, the student can familiarise himself with the trial that awaits him in the examination room. Further, the majority of the sets of questions published by the Commissioners contain tables showing the marks of successful and unsuccessful competitors in each subject, and thus afford a useful measure of the training necessary in order to succeed.

For all these reasons candidates are strongly urged to lay hands on all available papers of recent date for the grade they have in view, and to study them with the greatest care. A list of lately published sets of examination questions showing the price of each, will always be supplied gratis on application to the Civil Service Commission, Burlington Gardens, London, W. Any set required—if in print—may be purchased, either directly or through any bookseller, from the official agents—Messrs. Wyman & Sons, Limited, Fetter Lane, E.C.; Messrs. Oliver & Boyd, Edinburgh; and Mr. E. Ponsonby, 116, Grafton Street, Dublin.

CLERKS.—CLASS I.

With the possible exception of diplomatic posts, which are practically restricted to men of good family and social standing, first class clerkships are undoubtedly the most attractive appointments that the national service has to offer. They constitute the upper section of the general clerical staff in the various Government departments, and are characterised by responsible but not arduous duties, assured position, liberal increments, and a certain prospect of at least £800 to £1,000 a year. Nor is this all. Promotions are freely made from their ranks to still more desirable offices, including the highest dignities and most liberal incomes enjoyed by permanent officers of the State.

Salaries Official and Actual. Let us consider, first, the assured value of Class I. appointments in themselves. These vary somewhat in different offices, but are generally classified in three grades, advancement being made from one to the next as vacancies arise. In a few departments—notably the Treasury—the maximum attainable without promotion is as high as £1,200 a year; but with these exceptions the scale of salaries prescribed does not exceed the following:

Third Class, £200, advancing £20 yearly to £500.

Second Class, £600 or £700, by £25 to £800.

First Class, £850 or £900, by £50 to £1,000.

The remuneration for many of the posts offered is fixed on a less liberal basis. Commencing at £150, it rises by £15 yearly to £300, thence by £20 to £500 or more, and afterwards by £25 to £800 or £900.

Owing, however, to the special emoluments and liberal opportunities of promotion enjoyed by these clerks, the above rates by no means represent the real value of Class I. appointments. Many juniors are appointed as private secretaries to the principal officers, with extra remuneration of from £50 to £300 a year, and more senior members are eligible for departmental secretaryships and other leading staff positions at various rates between £1,000 and £1,800 a year. As a result, advancement is so brisk that the official scales of salary already quoted are, in practice, only minimum rates, and generally prove little more than nominal.

Examples of Promotion. Such an assertion is best proved by actual illustration. The following instances will serve to establish the point. A successful competitor in 1894 went to the Inland Revenue Department, with an initial salary of £150 and a £15 increment. Within a year he received a private secretaryship at an extra £50 yearly, later another worth £100, and after less than nine years service became a principal clerk at £600 rising to £700, when his stipend according to the official scale would have been £270. A colleague in the same office was even more successful, attaining the rank of principal clerk after only six years. In another instance known to the writer a clerk of two years' standing has already been advanced in salary from £150 to £350.

Of the posts attainable by senior officials, a few cases among many must suffice. The present Chairman of the Prison Commission entered as a Class I. clerk in 1881; he now receives £1,800 a year, and has had a K.C.B. conferred on him for his services. Another

officer, who began his career in 1886, is Deputy-Chairman of the Board of Inland Revenue, with a salary of £1,500. Other highly-placed officials who entered by the same means include the Assistant Secretary to the Treasury (earning £1,500 a year), the Secretary to the India Office, and the Director of Admiralty Stores, each receiving a salary of £1,200, and at least three Assistant Under-Secretaries of State at the same remuneration.

The Examinations. Class I. clerkships, as well as Ceylon cadetships and appointments in the Indian Civil Service [see Imperial Service] are awarded on the results of a joint open competition held in August of each year. Candidates who are eligible, may enter simultaneously for all three classes of appointment on payment of a single fee; and if successful, are allowed, according to their position on the combined list, to select which service they will enter.

Competitors for the posts under discussion must be between 22 and 24 years of age on the 1st August of the year in which they enter, but are entitled to deduct from their actual age any time spent in the naval or military service. A further and valuable provision enables those who have been for two years or more in the national Civil Service to deduct in the same way the time so employed, up to a maximum of five years. Subordinate members of the service are thus generally entitled to compete until the age of 29 years.

The examination subjects and the maximum marks assigned to each are as follows:

Mathematics and advanced mathematics, 1,200 *each*. English, French, Italian, German, Sanscrit, Arabic, logic and psychology, moral philosophy, political economy, and the following branches of natural science—chemistry, physics, geology, botany, zoology, and animal physiology, 600 *each*.

English composition, Greek history, Roman history, general modern history, political science, Roman law, and English law, 500 *each*.

English history (i.) to 1485; (ii.) 1485 to 1848, 400 *each*. Greek: translation, composition, and literature, 300 *each*. Latin, in similar divisions, 300 *each*.

Candidates may not offer more than four natural sciences, and those who select Latin or Greek must take up translation, and at least one other division of the subject. To hinder mere "smatterers" from succeeding by sheer multiplicity of papers, a deduction may be made from the marks gained in each branch, except mathematics and English composition. There is also a new provision that in future contests a competitor's papers shall not carry a greater total maximum than 6,000 marks. Its effect will be to limit each student to some ten subjects, or twelve at most, in place of the fifteen or sixteen which many candidates have offered in the past.

Choice of Subjects. With these restrictions, any of the branches named in our list may be taken, none being obligatory. The choice thus afforded is a very wide one; and, as the examination standard in each subject is very severe, it is imperative that a careful selection should be made at the outset of the course of study. In practice, it is found that successful contestants who are not brilliant mathematicians usually take up classics or modern languages as a mainstay, with history and law or moral sciences as supplementary mark-getters, the natural sciences being seldom taken seriously. Until recently, indeed, classics were regarded as almost essential to success, but the waning importance of this branch of a liberal education is already reflected in the Class I. pass-lists. The contest of August, 1905, was marked by unprecedented features, the first three places in the combined list falling to brilliant students of Edinburgh University, not one of whom took Greek or Latin, while the foremost offered three members of the natural science groups, and scored at least 75 per cent. in each.

The number of vacancies in the home service filled by competitions during each of the past six years has been as follows: 23, 27, 21, 43, 24, and, in 1905, about a score, the exact figures not having yet been announced. At the joint examination, some 200 to 220 candidates sit each year. Of these, the great majority compete for the home as well as for the foreign service, deciding afterwards, if successful, which branch they will enter. Badly placed candidates often prefer an Eastern post to indifferent offices in the home service; but those who stand high enough to secure a good choice of departments, generally select the career afforded by a Class I. appointment. These facts are strikingly illustrated by the latest report of the Civil Service Commissioners, which shows that 181 in a total of 212 contestants entered for Class I. clerkships, and of the first 13 successful competitors on the combined list, no fewer than 11 accepted these appointments in preference to posts in the East.

University Prizes. When we consider the keen competition for these positions, the large number of subjects essential for success, and the searching character of each paper, a doubt arises as to whether Class I. clerkships are within the scope of any private student, or of a subordinate civilian who has only his evenings free for study. The doubt is more than justified, alike by personal knowledge of the many hard-working minor officials who have striven vainly for these posts, and by the published results of recent competitions. The men taking high places on the list have come from the honours schools of the sister universities, in many instances with a post-graduate course of some months in a "crammer's shop" just before the examination. Not a single post for the past three years has been won by any save college men, and among the successes, London University—that *alma mater* of the struggling student—is represented by a solitary candidate. Reluctantly one is driven to admit that, unless when some intellectual marvel is the exception that proves the rule, these valuable appointments are practically close coverts for the brilliant men of the universities, and especially of Oxford and Cambridge.

Continued

EXAMINATIONS FOR THE NATIONAL CIVIL SERVICE

Postmen, Messengers, Office Keepers and other subordinates are generally appointed after nomination by the Head of Department concerned, after passing elementary test. Junior Inspectors, Board of Education (£200 to £800), are nominated by Secretary and appointed without examination.

Appointments.	Age Limits.	Educational standards (and special requirements, if any).	Fees.	Initial salaries, or weekly earnings, and maximum ordinarily attainable.	Average number of vacancies yearly.	Average number of candidates for each vacancy.
		APPOINTMENTS BY OPEN COMPETITION				
Posts on General Staff						
Clerk, Class I.	22 to 24	High and searching	£6	£150 or £200 to £800, £1,000	26	7
Clerk, Second Division	17 to 20	Secondary school grade	£2	£70 to £350	225	7
Assistant Clerk	19 to 21	Simple. Must have served as Boy Clerk	10s.	£55 to £150	190	3 to 4
Boy Clerk..	15 to 17	Simple	5s.	15s. to 19s. weekly	800	2·5
Boy Messenger	14 to 16	Elementary	1s.	9s. to 16s. 6d. weekly	100	Qualifying exam. only
In Particular Departments						
Assistant of Excise	19 to 22	Moderate	£1	£90 to £250, etc.	103	17
Assistant of Customs	18 to 21	Moderate	£1	£70 to £250, £540	72	14
Assistant Surveyor of Taxes ..	19 to 22	Somewhat high	£6	£100 to £550, etc.	16	12
Assis. Examiner, Patent Office..	20 to 25	Scientific subjects	£5	£150 to £450	35	4·5
Examiner, Exchequer and Audit Office	18 to 20	Somewhat high	£6	£100 to £350, £500	6	3 5
Junior Officer, Admiralty and War Office	18 to 20	Secondary school grade	£6	£100 to £500, £700	7	10
Port Service Clerk, Customs ..	17 to 20	Secondary school grade	£3	£70 to £300, £400	20	9
Clerk, Ecclesiastical Commission	18 to 22	Secondary school grade	£2	£70 to £350, £500	3	7
Estate Duty Clerk	21 to 27	Legal. Restricted to qualified solicitors	£2	£150 to £500, etc.	5	3
Clerk, Office of Woods	19 to 23	Legal. Must have been in a solicitor's office	£2	£100 to £400	Occasional	9
Sorter, Post Office	18 to 21	Elementary	4s.	18s. to £3 2s.	85	9
Learner, Post Office (London) ..	15 to 18	Elementary	4s.	8s., 16s. to £3 2s.	58	5
Learner, Post Office (Provincial)	14½ to 18	Elementary	4s.	8s., 16s. to £2 16s.	190	6 to 10
Apprentice, H.M. Dockyards ..	14 to 16	Simple	2s.	4s. to 14s. weekly while indentured	—	—
Boy Artificer, Royal Navy ..	15 to 16	Simple	2s.	3s. 6d. to 45s. 6d.	—	—
Abroad						
Student Interpreter, Turkey, Morocco, and Near East	18 to 24	Foreign languages essential	£4	£200, £500 to £1,000, etc.	4	3
Posts for Women						
Woman Clerk, G.P.O.	18 to 20	Secondary school standard	7s.6d.	£55 to £130	40	7
Girl Clerk, G.P.O.	16 to 18	Secondary school standard	7s.6d.	£35 to £37 10s.	47	9
Female Learner (London) ..	15 to 18	Elementary	3s.	7s., 14s. to £1 18s.	40	10
Female Learner (Provincial) ..	15 to 18	Elementary	3s.	5s., 12s. to £1 15s.	85	12
Female Sorter, Post Office ..	15 to 18	Elementary	2s.6d.	14s. to 30s. weekly	55	14
		APPOINTMENTS BY NOMINATION*				
Clerk and Attaché, Foreign Office	19 to 25 (after July, 1907, 22 to 25)	Languages essential. *N. Foreign Secretary*	£6	£150 to £1,000, etc.	8	4
Clerk, Royal Courts of Justice ..	20 to 30	Simple. *N. Lord Chancellor and others*	£6	£100 to £400, etc.	19	Qualifying exam. only
Assistant, British Museum ..	20 to 25	Science or Arts. *N. Principal Trustees*	£5	£100 to £500, etc.	4	3
Assistant Inspector of Mines ..	23 to 35	Mining subjects. *N. Home Secretary*	£6	£300 to £400, £800	3	1 to 4
Inspector of Factories	21 to 30 (38 for certain candidates)	Technical. *N. Home Secretary*	£3	£200 to £450, £550, etc.	4	2 to 4
Assistant to Inspector of Factories	21 to 40	Technical. *N. Home Secretary*	10s.	£100 to £150	3	1 to 3
Clerk, Prisons Service	18 to 22	Moderate. *N. Home Secretary*	£1	£70 to £300	3	—
Junior Clerk, Post Office ..	19 to 26	Secondary school subjects. *N. Postmaster General.* Restricted to postal servants	£1	£80, £100 to £200, £400	49	5
Prison Warder	24 to 42	Elementary. *N. Home Secretary*	2s.6d.	£60 to £78, etc., with allowances	80	Qualifying exam. only
Naval Appointments						
Assistant Clerk	17 to 18	Secondary school subjects. *N. First Lord of Admiralty*	£1	£45 to £400, etc.	40	3
Posts Abroad						
Student Interpreter, China, Japan, and Siam	18 to 24	Languages and law. *N. Foreign Secretary*	£4	£200 to £700, etc.	10	4
Consular Officer	22 to 30 (after Dec., 1906, 22 to 27)	Somewhat high. *N. Foreign Secretary*	£4	£200 to £700, etc.	4	5
Posts for Women						
Female Inspector of Factories..	21 to 40	Technical. *N. Home Secretary*	£1	£200 to £300	Occasional	Qualifying exam. only
Prison Wardress	24 to 42	Elementary. *N. Home Secretary*	2s.6d.	£45 to £70, with allowances	30	Qualifying exam. only
Female Typist	18 to 30	Simple, includes Typing. *N. Heads of Departments*	1s.	18s. to 25s., 35s. weekly	43	1 to 2

*NOTE.—*N.* in column 3 signifies Nominating Authority

THE STORY OF THE ROCKS

A Chronological Survey of the Various Geological Systems. Books for the Geological Student. Glossary of Geological Terms

Concluded from page 2067

By W. E. GARRETT FISHER

WE can here give only a very brief account of the chief periods which make up the geological record. We shall illustrate these as far as possible by the rocks of our own country.

Archæan Rocks. The oldest of all stratified rocks are called Archæan, or ancient. They are also known as Pre-Cambrian, because they came before the Cambrian, or oldest Primary rocks. These rocks represent the oldest stratified formations which we can study. They consist partly of igneous rocks, such as granites, which frequently have been altered into gneisses and schists ; partly of sedimentary rocks, sandstones, shales and conglomerates, and partly of volcanic tuffs, conglomerates, and sheets of lava. These oldest sedimentary rocks very seldom contain any remains of organic life, though here and there some relic of the first beginning of life on the earth is found even in these most ancient formations. The chief mountains of the Scotch Highlands are formed of the Archæan igneous rocks, whilst the sandstone hills of Loch Torridon may represent the Archæan sedimentary rocks.

81. CAMBRIAN FOSSIL

Primary Rocks. Cambrian System. The next great division of rocks is known as Primary ; it is also called Palæozoic, because it contains the most ancient relics of life in the shape of numerous fossils [81]. The oldest members of this division form the Cambrian System of rocks, so called because they were first studied in Wales, where they form the great series of slaty rocks which provide so many quarries, whilst Snowdon and its neighbouring peaks, like Scaw Fell in Cumberland, are formed from volcanic rocks which were produced about the same time that these slates were deposited in the shallow seas of the Cambrian age.

83. COPROLITE, OR FOSSIL EXCREMENT

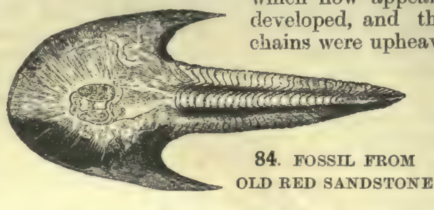
Silurian System. The next system of Primary rocks is the Silurian, so called because it was first examined in the Shropshire district once occupied by an ancient British tribe called the Silures. This system consists chiefly of a series of sandstones, gritstones, shales and slates, with occasional strata of limestone. The hills of the Lake District are largely composed of Silurian rocks, which also form the greater part of the southern uplands of Scotland. The Silurian system is of special interest to the geologist, because it is in these rocks that we find the earliest traces of vertebrate life [82]—the first recognisable ancestors of man.

Devonian System. The next system consists of the marine sediments, or limestones, which are called Devonian because they are commonly found in Devonshire. They consist mostly of sandstones, limestones, and shales, which are rich in the fossil remains of marine organisms [84], and also contain frequent veins of metallic ores. They may be well studied in the slates of Ilfracombe and in the limestones of Torquay. Closely allied with the Devonian system is the Old Red Sandstone, or the series of red sandstones, shales, and conglomerates which interpose in many districts between Silurian and Carboniferous rocks. The Old Red Sandstone was also laid down under water, since it contains the fossil remains of fishes, which Hugh Miller described so delightfully. This Old Red Sandstone, which has been moulded by denuding agencies into so many hilly districts, forms a great part of characteristic Scotch scenery ; the volcanic rocks which have been freely intruded into these masses, being harder than sandstone, have been left standing up in ranges of hills like the Pentlands and Cheviots.

82. SILURIAN FOSSIL

Carboniferous System. The next system of Primary rocks happens to be by far the most important of all rocks to mankind. This is the Carboniferous System, which includes the coal measures, to the energy stored in which we owe practically the whole of the industrial achievements of the last century. The carboniferous rocks consist of the coal measures, or layers of coal mingled with shale and sandstone, of the millstone grits, and carboniferous limestones. The coal seams consist of the decayed vegetable matter of ancient forests, laid down in beds in the manner described in an earlier section, resting on layers of clay, and divided by strata of shale and sandstone, which were laid down during the periodical submergence of the bed of each forest. The carboniferous rocks cover a large area of the surface of these islands, such as the great central coal field of Scotland and the important coal fields which lie on either side of the Pennine

range and in South Wales. The total thickness of the coal measures amounts in places to more than two miles, though the actual seams of coal occupy only a few score feet in thickness. These coal seams are entirely made up of fossil vegetation, but contain few animal remains. The carboniferous or mountain limestone which is frequently found associated with the coal measures, and forms the great Pennine range or backbone of England, is almost entirely composed of the remains of minute organisms, such as corals and foraminifera, which lived in the seas of the Carboniferous Age.



84. FOSSIL FROM OLD RED SANDSTONE

Permian System. The last or youngest system of the Primary rocks is known as the Permian. It includes the lower strata of what is known as the New Red Sandstone. The distinction between the upper and lower strata of these sandstones is chiefly due to the difference in the fossils included in them, which shows that a considerable period must have elapsed between their formation. The Permian rocks are very barren in fossils. They are seen to best advantage in the valleys of the Nith and Annan in South-west Scotland. To the same period belongs the great mass of magnesian limestone which runs down the East of England.

Secondary Rocks. We now come to the third of these great divisions, that of the Secondary, or Mesozoic rocks, so called because they are thought to represent what may be called the middle period in the development of life.

Triassic System. The oldest system of the Secondary rocks is known as Triassic, and includes the upper layers of the New Red Sandstone, formed also in the beds of ancient seas. The low-lying plains in the centre of England are largely formed of Triassic rocks, which may be studied where they reach the seashore at Lyme Regis or Budleigh Salterton.

Jurassic System. The next great system is that of the Jurassic rocks, so called because they compose the great mass of the Jura Mountains. They are very rich in fossils, especially in reptilian forms, such as the ichthyosaurus and the turtle-snake plesiosaurus. They largely consist of *oolitic* limestones, so called because of their egg-like structure. The well-known Oxford clay and Portland stones are familiar examples of Jurassic rocks.

Cretaceous System. The last of the three great Secondary systems is that of the Cretaceous, or chalky rocks. These vast deposits of chalk and allied rocks mainly consist of the shells and skeletons of tiny marine organisms which lived in the Cretaceous seas and deposited their hard portions upon their beds in vast masses. They are best illustrated, of course, by the imposing chalk cliffs which fringe a great part of our Channel coast, and which can be traced from Flamborough Head in Yorkshire to the coast of Dorset. These deposits are very rich in fossils, in which we notably see the Jurassic reptiles passing into the earliest bird forms.

Tertiary Rocks. The fourth of the main divisions into which the rocks of the earth's crust are classified in the geological record is called the Tertiary, or Cainozoic, because it contains the traces of recent life. It is usually divided into four systems. It was during this Tertiary period that the present distribution of land and sea into the continents and oceans which now appear in our maps was finally developed, and that most of our mountain chains were upheaved. Volcanic activity was very marked in all parts of the world, and there were great variations in climate from those of the present time, tropical conditions appearing in great part of what we now call the temperate zone.

Eocene System. The oldest of the Tertiary systems contains the Eocene rocks, on which London stands. The Eocene rocks consist almost entirely of sand and clay, more or less hardened. They appear to have been laid down either in fresh water or near a coast line, as we infer from the nature of the fossils which they contain. One of the oldest and most notable of Eocene rocks is the London clay, so called because of its general distribution throughout the basin [85] in which the metropolis is situated. It is a stiff brown or bluish clay, which contains numerous fossils and nodules of clayey limestone. A more recent Eocene rock may be seen in the Bagshot sands, consisting of yellow siliceous sand, with few fossils, but containing the large sandstone blocks known as Grey Wethers or Druid Stones.

Oligocene System. The next series of Tertiary rocks is known as the Oligocene rocks. This includes the thinly-bedded deposits of sand, clay, and limestone which are found in the Isle of Wight. They were apparently laid down in shallow brackish water, and contain numerous fossils, among which we may specially note the abundant variety of insect life which appears to have existed in Oligocene times.

Miocene System. The Miocene system, which comes next, coincides with a chronological period in which our islands and the greater part of Northern Europe had been gradually elevated above the sea. Consequently no Miocene deposits are known to occur in our islands, since they were only laid down under water, and this part of the world then consisted of dry land. As far as we are concerned, the Miocene age was an age of denudation and land-moulding rather than of construction. Where they exist, as in France, the Miocene beds chiefly consist of sand and gravel rocks. They are rich in fossils, in which we see a gradual approach to the fauna of the present day.

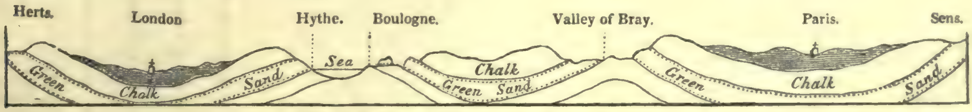
Pliocene System. The last of the four great Tertiary systems is known as the Pliocene.

During this period there seems to have been local subsidences in the British Islands, and consequently Pliocene deposits appear in some parts of the country, chiefly in the counties of Norfolk and Suffolk, where they constitute the accumulations of sandy rocks known as Crag.

Quaternary Rocks. The last of the great divisions of the geological record is known as the Quaternary or Post-tertiary. This division reaches down to our time; we are living, in fact, in the Quaternary Age. It is usually divided into two systems—the Glacial, or Pleistocene; and the Post-glacial, or Human Period, during which man is known with certainty to have been in course of development.

Pleistocene System. The Glacial Period. The Pleistocene system of rocks received its mould during what is known as the Glacial Period, or Ice Age, which divides the modern geological history of the Northern Hemisphere from all that has gone before. During the greater part of this period, which is but of yesterday in comparison with the vast age of the systems which we have hitherto been considering, the whole of our islands and of Northern Europe was buried under a vast sheet of ice, which may have been as much as a mile in thickness in parts of Britain. The whole of our country is full of evidence of the former existence of these gigantic glaciers. Everywhere the land contours have been rounded and smoothed by glacial motion, whilst the various signs of glacial action which we described in an earlier chapter are abundant; polished and striated stones, erratic blocks, moraines, and the other symptoms associated with the presence of glaciers are to be found in all parts of our country. A great deal of the surface of our islands is covered with *boulder-clay*, or *till*, a mass of earthy, stony, and sandy material which is an unmistakable product of glacial action. During the Glacial Period there is little doubt that the land of the Northern Hemisphere underwent various elevations and subsidences, the traces of which are preserved in the form of submarine deposits and aerial denudations. It is probable that, although throughout the Pleistocene period our islands were more or less glaciated, there were temporary alleviations in the climate. Some have professed to have traced as many as five distinct periods during which ice covered the land, with intervals of a mild and open climate. However that may be, there is no doubt whatever that the Glacial Period stamped its mark upon our landscape shortly before man came into existence, or at least began to inhabit this part of the world. These Pleistocene deposits are almost entirely made up of boulder-clay and similar glacial beds, which, as we might expect, are somewhat poor in fossils, those which exist being chiefly the remains of Arctic land animals and of marine organisms.

Post-Glacial Period. The last period in the geological record, in which we are still living, is known as the Recent, Post-glacial, or Human Period. No rocks of any great importance have been formed during this period, although, of course, the general agencies of denudation and reconstruction have been at work to modify the face of the land. But even the hundreds of thousands of years which are believed to have elapsed since the ice disappeared from our islands are but a day in the sight of the geologist, and they have not sufficed to destroy the general outlines and nature of the land as these were left at the close of the Glacial period. The most interesting fact connected with these recent deposits is that they contain proofs of the early existence of man. His primitive instruments, first of rudely-chipped flint, then of smooth and beautifully-worked flint, then of bronze and afterwards of iron, are found buried in the deposits brought down by rivers, strewing the floor of the ancient caverns which he shared with the cave bear and the sabre-toothed tiger, and buried deep beneath the soil of the earth by the action of the various denuding and constructive agencies. Along with these tools have been found some very interesting drawings, scratchings on bone or ivory, which have thrown great light upon the habits of prehistoric man [**85**]. The history of our species, before history properly so called began, is divided by geologists into Palæolithic and Neolithic times, during which man made his implements solely of flint and bone. The alluvial deposits, or river drifts, have given up much evidence bearing upon the nature and habits of man when he first emerged upon the stage of the world, as may have happened in our hemisphere shortly after the close of the glacial period, probably from one to two hundred thousand years ago, but the study of these comparatively recent times is outside the sphere of geology proper, and belongs rather to the anthropologist and archæologist.



85. LONDON AND PARIS BASINS (Lyell)

Bibliography. The student who has mastered the outline of geology given in this course will now desire to know what books he should read in order to enlarge his knowledge. There is a large supply of such works in our language, without mentioning the admirable treatises which are only available to those who can read French and German. Amongst these the following works are deserving of special recommendation.

General Treatises. The best work in our language is, without doubt, Sir Archibald Geikie's large "Textbook of Geology" (Macmillan. 2 vols. 30s. net), of which the fourth edition was published in 1903. This admirable

and lucid exposition of the science of the earth holds the place which was occupied for many years by Sir Charles Lyell's "Principles of Geology." The student who has gone through it with the assistance of practical work in the field and the laboratory will have little left to learn. The same author has published two works on a smaller scale—"Primer of Geology" and "Classbook of Geology" (Macmillan. 1s. and 5s.)—which may equally be recommended to those who have less time available. Dr. J. E. Marr's "Introduction to Geology" (Cambridge University Press. 3s. net) is perhaps the best of recent attempts to explain the scope and methods of geology, without an excess of detail. Professor A. H. Green's "Physical Geology" is a valuable supplement to Geikie, and the latest American work, Messrs. Chamberlin and Salisbury's "Geology" (Murray. Vol. 1. 21s.) handles the process of physical change in a new and illuminative fashion.

Practical Treatises. The best account of methods of geological investigation on a small scale is to be found in Sir Archibald Geikie's "Outlines of Field Geology," fifth edition (Macmillan. 3s. 6d.), which may be supplemented by W. H. Penning's larger "Textbook of Field Geology" (Baillière, Tindal, & Cox).

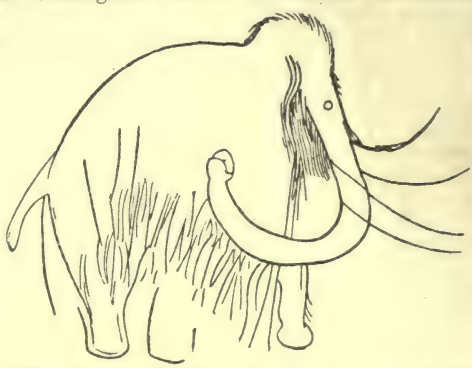
Special Surveys. The geology of a particular country affords a very interesting and instructive field of study. Three books on this subject deserve special mention: Sir Archibald Geikie's admirable "Scenery of Scotland" (Macmillan. 10s. net), Mr. A. J. Jukes-Browne's "Building of the British Isles" (Bell. 7s. 6d.), and Lord Avebury's "Scenery of Switzerland" (Macmillan. 6s.). There are similar treatises, in various languages, for nearly every country in the world, but these three will afford the English student plenty of occupation to begin with.

History of Geology. The first four chapters of Lyell's "Principles of Geology" contain an outline of the history of geology. Sir Archibald Geikie's "Founders of Geology," second edition (Macmillan. 10s. net), gives a fuller account of the growth of this science from the earliest times, treated in a biographical fashion. Mrs. Ogilvie Gordon's abridged translation of the German Professor Zittel's "History of Geology and Palæontology" (Scott. 6s.) is also a valuable book of reference.

Mineralogy. The leading English textbook of mineralogy, which describes the nature and explains the identification of the various minerals which go to the building up of rocks, is Professor Henry A. Miers's "Mineralogy" (Macmillan. 25s. net). The American Dana's "System of Mineralogy" is still the standard work of reference. Among the numerous smaller handbooks, F. Rutley's "Mineralogy" (Murby. 2s.) is still as good as any.

Palæontology. The chief work on palæontology, or the geological record of ancient life, is the English translation of Professor Zittel's "Textbook of Palæontology" by C. R. Eastman. Dr. A. Smith Woodward's "Outlines of Vertebrate Palæontology for Students of Zoology" is a valuable help.

Departments of Geology. The works dealing with special departments of geology are very numerous. We may mention Professor Milne's "Earthquakes" and Professor Judd's "Volcanoes," both in the International Science Series (Kegan Paul); Mr. Davison's "Study of Recent Earthquakes" and Professor Hull's "Volcanoes, Past and Present," in the Contemporary Science Series (Scott); Sir A. Geikie's "Ancient Volcanoes of Great Britain" (Macmillan. 36s. net); Tyndall's "Glaciers of the Alps" and Sir R. Ball's "Cause of an Ice Age." Professor James Geikie's works on "The Great Ice Age" and "Prehistoric Europe" give the best account of geologically recent times. Hugh Miller's "Old Red Sandstone" may still be read with pleasure for its fascinating pictures of a vanished era, though it is somewhat out of date. Professor Hull's books on "The Coal Fields of Great Britain" and "Our Coal Resources" are important contributions to a special field of geological work. By the time he has read all these books, the student should require no further advice as to his work.



86. MAMMOTH ENGRAVED ON WALL, CAVE OF COMBARELLES, DORDOGNE

Geological Maps. It is impossible to study the geology of a district without a good map. The best maps are those published by the Geological Survey of Great Britain, and by similar organisations in most civilised countries. These are on scales ranging from 6 in. to the mile to 4 miles to the inch; the latter scale is large enough for most purposes of the student, who will do well to obtain the sheets for the districts with which he is most familiar, and study them carefully on the ground. Small-scale geological maps of a whole country, such as are published by Messrs. Bartholomew, Stanford, and Philip, will also be found indispensable.

Geology concluded

A SHORT DICTIONARY OF TERMS USED IN GEOLOGY

It is impossible to include the names of rocks and minerals in the space that can be devoted to this glossary. Most of them are explained in the course

ÆOLIAN, or AERIAL DEPOSITS—Those produced by the action of atmospheric agencies.
Amorphous—Without definite structure.
Anticline—A tilting of strata into an arch.
Aqueous Deposits—Deposits due to the action of water.
Archæan—The most ancient rocks.
Arenaceous Rocks—Sandy rocks.
Argillaceous Rocks—Clayey rocks.
Atmosphere—The gaseous envelope surrounding a planet.
Axis—The line about which a crystal or other structure displays symmetry.

BEDDING—The arrangement of rocks in layers or bedding planes.
Boss—A mass of volcanic rock pushed up to the surface.
Boulder Clay—A stiff clay full of stones and boulders, left by glacial action.

CAINOZOIC—The period of recent life.
Cambrian — The oldest Primary system.
Calcareous—Limy rocks.
Carbonaceous—Coal-bearing rocks, or those containing carbon.
Carboniferous—The fourth Primary system, including the coal measures.
Catastrophe, or Cataclysm—A convulsion of Nature which causes great and sudden geological changes.
Cleavage—The division of a rock into layers, due to pressure.
Clinometer—An instrument for measuring the slope of strata.
Colloid—A jelly-like, non-crystalline mineral structure.
Conformable—Strata laid down regularly on one another.
Contour Line—A line drawn through a series of points at the same height on a map.
Crater—The basin into which a volcanic vent opens.
Cretaceous—The latest Secondary system.
Crystalline Minerals or Rocks—Those consisting of crystals, or symmetrical structures produced by cooling or precipitation.
Crust—The upper solid portion of the earth.

DÉBRIS, or DETRITUS—The remains of rocks broken down by erosion or denudation.
Denudation—The wearing away of rock by natural agencies.
Derivative Rocks—Rocks produced by some modification of an older rock.
Devitrification—The loss of glassy characteristics, due to weathering.
Devonian, or Old Red Sandstone—The third Primary system.
Dip—The slope of strata from the horizontal.
Dislocation—A fracture in rocks accompanied by disunion of the strata.
Dyke—A vertical seam of volcanic rock, usually found standing up like a wall.

EARTHQUAKE—A rapid movement of the earth's surface.
Eocene—The oldest Tertiary system.
Epigene—Above the surface of the earth.
Erratic Blocks—Boulders transported by glaciers.
Erosion—Wearing away of rocks by natural agencies.

FAULT—A dislocation.
Fissure—A crack in rock formations.
Fluviatile—Pertaining to rivers.
Foliation—A leaf-like structure in certain minerals.
Fossil—The remains of a plant or animal preserved in stratified rocks.
Fossiliferous Rocks—Rocks which contain fossils.

GEOLOGY—The science of the earth.
Geyser—An intermittent fountain of heated water.
Glaciation—The action of glaciers on rocks.
Glacier—A river of ice.
Grey Wethers—Blocks of Eocene sandstone, known in Wiltshire as Druid stones.

HADE—The angle of a dislocation to the vertical.
Hydrosphere—The watery envelope partly surrounding the earth.
Hypogene—Subterranean.

IGNEOUS ROCKS—Those formed by the action of heat.
Impermeable—Through which water cannot penetrate.
Intrusive Rock — A rock forced through an older formation.

JOINTS—Natural divisions in rocks, usually more or less vertical.
Jurassic — The middle Secondary system.

LACUSTRINE—Pertaining to a lake.
Lagoon—A salt water lake connected with the sea.
Lake—A body of fresh or salt water entirely surrounded by land.
Lamina—A thin plate.
Lithosphere—The solid globe of the earth.
Loam—A fertile soil, consisting of clay and sand with a mixture of organic matter.

MAGMA—The viscous liquid from which the igneous rocks solidified.
Marine—Pertaining to the sea.
Marl—A calcareous clay.
Matrix—The general body of a rock in which other substances are embedded.
Mesozoic—The middle period of life on the earth.
Metamorphic Rocks—Those which have been modified by heat, pressure, or chemical action.
Mineral—A chemical element or inorganic compound of which rocks are formed.
Mineralogy—The science of minerals.
Miocene—The third Tertiary system.
Moraine—The accumulation of earthy and stony matter left by a glacier.

NEBULA—A celestial body composed of gas or of a cloud of meteorites—the raw material of stars and planets.
Neck—The solidified pipe of lava of an extinct volcano.
Neozoic—The period of recent life.

OLIGOCENE—The second Tertiary system.
Outcrop—The part of a rock stratum which emerges on the earth's surface.

PALÆOZOIC—The period of most ancient life.
Permeable—Through which water can pass.
Permian — The youngest Primary system.
Petrography—The science of rocks.
Planes—The roughly parallel divisions of rocks caused by cleavage, stratification, etc.
Pleistocene—The glacial or older Quaternary system.
Pliocene — The youngest Tertiary system.
Post-Glacial—The Human Period.
Plutonic Rocks—Those igneous rocks which have taken shape below the earth's surface.
Pre-Cambrian—The oldest system of stratified rocks.
Primary Rocks—The second oldest of the five main divisions of stratified rocks.

QUATERNARY—The most recent stratified rocks.

RIB—A kind of wall of stone.
Roches Moutonnées—Rocks rounded by glacial action so that at a distance they look like sheep.
Rock—A mass of earthy or stony matter composed of one or more simple minerals.

SEAM—A layer of mineral, usually applied to coal.
Secondary—The third of the five periods of stratified rocks.
Secular Movements — Those prolonged through many centuries or ages.
Sedimentary Rocks—Those produced by the solidification of sediments left by water.
Seismic—Relating to earthquakes.
Siliceous Rocks—Flinty rocks.
Sill—A layer of volcanic rock.
Silurian—The second Primary system.
Soil—The detritus covering the earth's surface and capable of supporting vegetable life.
Spicule—A needle-shaped body.
Strata—Layers of rock, usually more or less horizontal.
Stratified Rock—Rock arranged in definite layers.
Striation—Scratching of stones due to glacial action.
Strike—The direction of the outcrop of strata.
Subsidence—The gradual sinking of the land.
Subsoil—Consisting generally of earth and stones, intermediate between the soil and the solid rock.
Syncline—An arrangement of tilted strata in troughs.

TERTIARY — The fourth period of stratified rocks.
Throw—The vertical displacement of strata by a dislocation or fault.
Till—Boulder clay.
Triassic — The oldest Secondary system.
Tuff—Volcanic débris, often hardened into rock.

UNCONFORMITY—The disposition of a set of strata upon older ones which lie at a different angle.
Uniformitarianism — The doctrine that similar causes have been at work throughout geological history to produce the same results.
Upheaval—The slow rising of the land.

VENT—The communication between a crater and the subterranean reservoir of molten lava.
Vitreous—Glassy rocks or minerals.
Volcano—A mountain produced by the ejection of lava from the interior of the earth.
Volcanic Rocks—Igneous rocks which have solidified on the earth's surface.

WEATHERING—The modification of rocks by atmospheric or meteorological agencies.

Group 3
PSYCHOLOGY
3
Continued from page 2120

THOUGHT AND MEMORY

The Function of Attention, and its Relation to Thinking Power. Memory and Efforts of Memory. Association of Ideas. How to Gain Knowledge

By Dr. C. W. SALEEBY

DIRECTLY we think of it, we recognise the remarkable fact which the Germans call the *narrowness of consciousness.* A thousand impressions are affecting our sense organs, but we tend, when fully awake, to ignore nearly all and to attend to one or to one group of them. A distinguished psychologist, in a quite recent book, calls this a mystery, but the remarkable work of a physiologist, Professor Sherrington, of Manchester, has gone very far to explain the mystery. He is the greatest living student of reflex action, and he has shown that it is a characteristic of one or another of many stimuli that may be simultaneously striving to gain our attention, to arouse a series of reflex actions, and, at the same time, to inhibit all other competing stimuli from affecting us.

One Thing at a Time. Hence it is that we are able to give our undivided attention to one thing at a time, and hence also, ultimately, is the reason why the will is not divided and why we do not simultaneously attempt to perform half a dozen actions that are mutually incompatible. Professor Sherrington has shown, for instance—and the discovery is typical of all action—that when two objects are simultaneously presented to the eye the rays of light from each of them strike the retina at a particular point. The natural reflex in each case causes such a movement of the eyeball that the most sensitive part of the retina is swung round so as to coincide with that point, and so as to make vision most accurate. Now, supposing both of these objects are to the left, the rays of light from each of them tend simultaneously to arouse movements in the muscles which swing the eyeballs to the left. If, as might be expected, the two stimuli were added together, the eyeball would be swung too far round, and neither object would be clearly seen. On the other hand, if a compromise were struck between the two stimuli, the eyeball would swing round too far for clear vision of the one object, yet not far enough for clear vision of the other.

But what actually happens is neither of these things. One stimulus or the other captures the whole machine, so to speak, so that the image of the corresponding object is clearly thrown upon the most sensitive part of the retina. The reflex thus initiated is able completely to inhibit the action of the other reflex.

The Sense Telephone. This great discovery by Professor Sherrington that reflexes inhibit one another, has explained how it is that our complex nervous system, with its millions of reflex arcs, acts as a unit, and has also provided us with the key to the extraordinary phenomenon of attention. The professor has shown that there is a *common path* which corresponds to the trunk line of the telephone. When one subscriber gains possession of this, the others must wait. Similarly, one series of sensory fibres, as, for instance, the auditory nerve when we listen to something that deeply interests us, has captured the common path and inhibits the action of all other sensory impulses, so that we do not withdraw our hand even when someone pinches it very firmly. We desire to emphasise the assertion that this discovery constitutes the most important substantial advance in our knowledge of attention, and in our knowledge of voluntary action, since Herbert's Spencer's great discovery of the evolution of will from reflex action.

It is a noteworthy and important fact that, though children readily respond to exciting stimuli from without, "they have very few organised interests," as Professor James says, "which enable them to sustain their interest." Hence that extreme mobility of the attention with which we are all familiar in children. Here we see how simple is the determination of the attention by any new stimulus, where the mind is not sufficiently developed to enable it to retain its interest in the matter in hand. The first importance of these facts is this: that the child's incapacity for sustaining its attention has to be recognised in education. In the case of a young child, it does extremely well to attend for a quarter of an hour to any one subject that entails difficulty. It is an almost invariable fact that the lessons given to our school children are individually too long.

Thinking Power. On the other hand, it is the duty of the teacher to train the attention—to train it, but not to strain it. The importance of training it is overwhelming, though people vary very much in this respect, some requiring to undergo severe conscious discipline, which is superfluous for others. But the faculty of keeping to the point, the faculty of sustaining the attention, notwithstanding difficulty, notwithstanding the temptations of all sorts of by-paths, is one of the highest, rarest, and most valuable characters of the human mind. The present writer is very far, indeed, from accepting the view of Carlyle, "that genius is an infinite capacity for taking trouble." He infinitely prefers Carlyle's much truer dictum that "genius is the clearer presence of God Most High in a man." But the familiar quotation expresses a very important fact. No matter what the native genius may be, it cannot yield its due fruit unless there be a great power of attention. At any debate one can recognise

in a moment the difference between those who are able to attend and those who are diverted by chance associations—in short, those who have thinking power and those who have not. The power of public speaking, or of writing coherently and consecutively on any subject, entirely depends upon the faculty of sustaining the attention, notwithstanding a thousand temptations to wander, temptations induced by sensations from without or by random ideas from within.

Attention Essential in all Things. Two great practical points emerge from the very brief study of this subject which we have been able to afford. First, that the due understanding of the evolution of attention in the individual would so modify our educational practice as to make lessons far more attractive to children, far more useful, and truly *educative*—that is to say, a "drawing out" of the mind—rather than, as often happens when attention is demanded for excessive periods, blunting interest and repressing the mental faculties. Secondly, the power of attention is an essential for every kind of successful mental work ; it applies alike to the solution of a geometrical problem, writing an essay, making a speech, or playing a sonata. He who desires to make the most of his inherent mental powers must consciously develop the power of attention. If these pages lead him to follow our advice, the SELF-EDUCATOR will be worth many times its weight in radium.

Memory. Now, if the faculty of attention be important, what are we to say of the faculty of retention—the faculty of memory ? If we could not remember we could not learn, and this is true alike of learning to write or learning to walk. Now, memory unquestionably has a physical basis, and this basis is fundamental to all those actions of the mind in which memory is involved. Habit, for instance, may very well be defined as organic memory. Professor James says : "An acquired habit, from the physiological point of view, is nothing but a new pathway of discharge formed in the brain by which certain incoming currents ever after tend to escape." That definition will be perfectly intelligible to the reader of what we have already said regarding reflex action. As Professor James points out, this definition of habit—the formation of pathways of discharge—helps us to understand not only habit itself, but also what we commonly understand by memory, the association of ideas, perception, and reasoning. When we acquire a habit, or when we remember, it means that some change of greater or less permanence has been produced in our nervous tissues ; and this, indeed, is the supreme feature of nervous tissue—its plasticity, its modifiability, its power of learning and remembering.

Now, there are certain facts which go some little way, at any rate, towards illustrating the very simplest aspects of memory. There are many toys, such as the kaleidoscope and the now familiar cinematograph, which depend for their success upon what are called after-sensations or after-images. In the case of the eye, to take an instance, the sensation aroused by the light from an object momentarily thrown upon it lasts for about one-fortieth of a second after the light is withdrawn. Plainly, then, there is the persistence of something in the retina, and that something, of course, is the change which the light induced. There are many popular experiments, sometimes used in advertisements, which employ this principle.

Memory Images. But from these we may turn to what are called *memory images*, the sense of sight again serving us conveniently for illustration. After we have looked carefully at any object that is not too complex, we can shut our eyes, and for a short time afterwards we can recall the image of that object. It would be idle to attempt any assertion as to what actually happens in such a case. But, at any rate, it is evident that there must be some physical basis, whether in the retina or in the brain—some physical change which enables us to remember. Furthermore, the experiment illustrates two facts of memory which should never be confused—the power to retain and the power to recall. In this case it is plain that something has been retained, and it is also plain that somehow, when we try, we can actually recall. Speaking generally of the whole aspect of memory, different persons vary widely in these two aspects of the faculty and also in the proportion between them. It is perfectly familiar to all that one may have a name in one's head but may not be able to recall it. This we indicate by saying "I have forgotten the name for the moment." The retentive aspect of memory is not defective, but the power of recalling what is retained is slightly imperfect. We may add also that in complete memory one knows that one is remembering. Thus Professor James says : "Memory is the knowledge of an event or fact, or perhaps of a former state of mind, with the additional consciousness that we have thought or experienced it before." Now, in so far as retention is concerned, there is no more that is essential to be said.

"Trying to Remember." In order to understand the power of recalling or recollecting or reproducing any past mental state, we must plunge into a great subject which is called the *association of ideas*. This is one of the most important principles in psychology, and has been especially studied by the Anglo-Saxon school of psychologists. It was first definitely formulated by Hobbes, and has been greatly contributed to by Lok, James Mill and his son (John Stuart Mill), Alexander Bain, and Herbert Spencer. We may follow Professor James in quoting the admirable description given by the elder Mill of the manner in which recollection is achieved by the association of ideas. "There is a state of mind, familiar to all men, in which we are said to remember. In this state it is certain we have not in the mind the idea which we are trying to have in it. How is it, then, that we proceed, in the course of our endeavour, to procure its introduction into the mind. If we have not the idea itself, we have certain ideas connected with it. We run over these ideas, one after another, in hopes that some one of them will

suggest the idea of which we are in quest, and if any one of them does, it is always one so connected with it as to call it up in the way of association. I meet an old acquaintance whose name I do not remember, and wish to recollect. I run over a number of names, in hopes that some of them may be associated with the idea of the individual. I think of all the circumstances in which I have seen him engaged, the time when I knew him, the persons along with whom I knew him, the things he did, or the things he suffered, and if I chance upon any idea with which the name is associated, then immediately I have the recollection; if not, my pursuit of it is in vain."

Association of Ideas. There is another set of cases, very familiar, but affording very important evidence on the subject. The elder Mill goes on: "It frequently happens that there are matters which we desire not to forget. What is the contrivance to which we have recourse for preserving the memory—that is, for making sure that it will be called into existence when it is our wish that it should? All men invariably employ the same expedient. They endeavour to form an association between the idea of the thing to be remembered and some sensation, or some idea which they know beforehand will occur at or near the time when they wish the remembrance to be in their minds. If this association is formed and the association of idea with which it has been formed occurs, the sensation, or idea, calls up the remembrance, and the object of him who formed the association is attained. To use a vulgar instance, a man receives a commission from his friend, and, that he may not forget it, ties a knot in his handkerchief. How is this fact to be explained? First of all, the idea of the commission is associated with the making of the knot. Next, the handkerchief is a thing which it is known beforehand will be frequently seen, and of course at no great distance of time from the occasion on which the memory is desired. The handkerchief being seen, the knot is seen, and this sensation recalls the idea of the commission, between which and itself the association had been purposely formed."

Thus we *recall* by the machinery of *association*, which we shall discuss later. Meanwhile we must refer to certain practical points of great interest in relation to memory.

The Two Kinds of Memory. There are quite definitely two distinct kinds of good memory, one of which, for convenience, we may call inborn and the other acquired. Fortunate is he who can combine both. The good memory, which is a piece of native good fortune, depends upon direct retentiveness of the nervous tissue of the individual. People so blest hear a name, or a date, or a quotation, and, when occasion arises, it is found that these things are remembered. Such people have an enormous advantage over their neighbours who, having reached adult life, can do very little more than relearn that which they have already known but are constantly forgetting. These latter people cannot go on; whereas those who have a really fine native memory are able to advance until old age creeps upon them. But as we grow old our nervous tissue loses whatever retentiveness it had—that is to say, it loses any power of making any fresh retentions, whereas memories of childhood may remain. There is no evidence whatever that this inborn peculiarity of nervous tissue can be modified by any device.

How to Make our Knowledge ours. But, on the other hand, a good memory may mean not any special power of retentiveness but the possession of good and numerous associations in the mind. The greater the number of associations of any given fact, the more surely shall we retain our memory of it. Now, in the case of intellectual knowledge, the number of associations depends entirely upon the extent and value of the reflection to which the matter in question has been subjected. The more we co-ordinate, or colligate, or associate, our knowledge or experiences, the more surely are they ours. Now, of course, we think most about what most interests us, and so our memory will be good accordingly. The present writer is absolutely incapable of remembering stories; he does not remember the plot of any of the novels which he used to read, and can scarcely ever recall even a good joke. Other people who have a natural interest in them, will retain the plots of novels in the most remarkable fashion. We often exclaim in wonder at the amazing extent of knowledge which a specialist of any order no matter whether a chauffeur or a cardinal, possesses of the particular subject which concerns him. The reason is, in the first place, that the facts of this subject have been fully perceived in the first instance, but more especially that they have been interwoven with one another so that they all hang together. They have been interwoven because they have been thought about, utilised, and correlated, and it is the law of the association of ideas that fully explains the possession of good memories of this type.

Continued

CONSTRUCTING BRICK WALLS

Continued from page 2178

Setting and Laying Footings. Plumbing the Angles. A Fair Face. Damp Courses. Hollow Walls and Air Bricks. Corbelling and Cornices. Mortar Joints

By Professor R. ELSEY SMITH

WE are now in a position to consider the actual method of carrying out brickwork. The necessary excavation will have been made by the excavator and the trenches filled in to the required depth with a layer of concrete, the top of which is left level and true. The standards for the scaffold and at least one or two ledgers will have been got into position, so that the bricklayers' work, when it commences, may proceed without interruption.

Setting out the Walls. The position of the walls and their footings will have been previously marked, and the first operation will be to test the accuracy of the concrete in relation to the position of the walls, and to mark on the concrete foundations the position of the angle bricks of the footings by straining lines between the setting-out boards [see page 309]; a plummet should be dropped from their intersection and a brick accurately set on a small mortar bed to mark each angle; the dimensions should be carefully checked over again after the bricks are actually set out so that any slight inaccuracy may be corrected while this is still an easy matter.

Laying the Footings. When the setting out is verified the actual laying of bricks begins with the bottom course of footings. *Footings* consist of a base wider than the wall itself, and serve to increase its stability and to distribute its weight over the wider area of the concrete. In London, footings are required by the London Building Act, 1894, to all walls except those which rest upon girders; the minimum width of the bottom course of footings is required to be twice the width of the wall under which it occurs, and the total height of the footings is required to be, as a minimum, two-thirds of the width of the wall at its *base*—that is, at the course next above the footings. These rules are very generally accepted as the reasonable minimum requirements beyond the jurisdiction of the London Building Act. The footings of brick walls are formed of successive courses of bricks; the minimum size of each course is made one half-brick wider than the course above it, and projects beyond it 2¼ in. both in front and at the back. It will be seen, therefore, that to provide the requisite width of footings one course will be required for every half-brick in the thickness of the wall, and as the height of a brick (3 in.) is two-thirds of the width (4½ in.), this number of courses will also give the requisite height for the footings.

Bond of Footings. Footings are, with very rare exceptions, buried below the ground level, and we need not, therefore, consider the appearance of them as of such importance as to make us abandon the most suitable method of construction; whether the wall above is English or Flemish bond, the footings in all cases are laid in header bond. If the footings to a wall having a stopped end be examined [72], it will be observed that this secures a perfect system of bonding without the use of closers; for each course projects at the end of the wall 2¼ in., or the width of a closer, and also, as already pointed out, to the same extent both in front and rear, and a very thorough and complete bond results. The great advantage of using nothing but headers will be observed in looking at a cross section [73], for in each course the headers that form the front row cover the bricks below, which are also headers, to the extent of 6¾ in. by 4½ in., or three-fourths of the entire area; whereas, if the brick below were a stretcher it would be covered only to the extent of 2¼ in. by 9 in., or one half its area. And as one of the important functions of these footings is to distribute the pressure from the wall outwards, this arrangement is clearly one that will perform this duty with the least likelihood of producing a fracture. It is, however, obvious that, as the width of the footings increases by only a half-brick in each course, a single course of stretchers must be used in every alternate course; but, excepting in the case of the first course of footings to a one-brick wall, this never shows on either face, but is placed at or near the centre of the wall. It should be so arranged that two successive courses of stretchers do not come vertically one above the other [see the section, 73]. Where a wall is not stopped, but is returned, the angle brick in each course must show as a stretcher in the return wall, but immediately beyond this brick the use of headers is resumed [83].

Double Course of Footings. It is a useful practice to build the lowest course of footings two bricks high [78], and this should invariably be done if circumstances permit of the concrete bed being omitted. This is sometimes done for all courses [78] where the loads are heavy and the foundations deep enough; but though advantageous when great strength in the footings is required, this doubles the depth of the footings and naturally adds to the cost. Any course of footings that is formed with two courses of bricks will show ordinary English bond, a course of headers above a course of stretchers on the face.

Marking the Line of Footings. In laying the bricks after the angles have been fixed a line is stretched to mark the inner and outer face of the wall; this is fixed at each end to an iron spindle having a blunt blade. The

line can be wound round the spindle to shorten it, or unwound to lengthen it, as required, and the blade is inserted into a joint; this line is tightly strained, and marks the level of the top of the course. When these preparations have been made a layer of mortar is spread upon the concrete bed which, if it has got thoroughly dry, should be first wetted, to prevent undue absorption of the water in the mortar. Starting from the angle brick, some mortar will be plastered on the side of it, and the next brick will be laid on the mortar bed a short distance from its final position and then moved into position, thus forcing up a little mortar into the vertical joint.

The front row of bricks on each face is first completed, and, when it comes to filling in the last brick before the next angle is reached, a little mortar is usually spread on it to form the last vertical joint. This outer row of bricks is carefully adjusted to the line, and may be tested with a level [**34**, page 1951]. The bricks are knocked down to their proper level with the side or with the butt-end of the handle of the trowel. The outer line of bricks being carefully placed, the filling in may proceed much more rapidly, as the same care in aligning the bricks is not necessary.

Flushing up the Joints. When the course is complete it will be found that the vertical joints on the face are filled, but that many of the other vertical joints are still open. Mortar is spread over the top of the course and worked into these joints with the trowel, and it is important that these joints should be well filled to ensure the full strength of the wall being attained and, in the case of walls above the ground level, to prevent rain being driven through the walls at imperfect joints. This procees is described as *flushing up.*

The next course of footings is set out in a similar manner, being formed one-quarter brick within the line of the first until the top course of footings is completed.

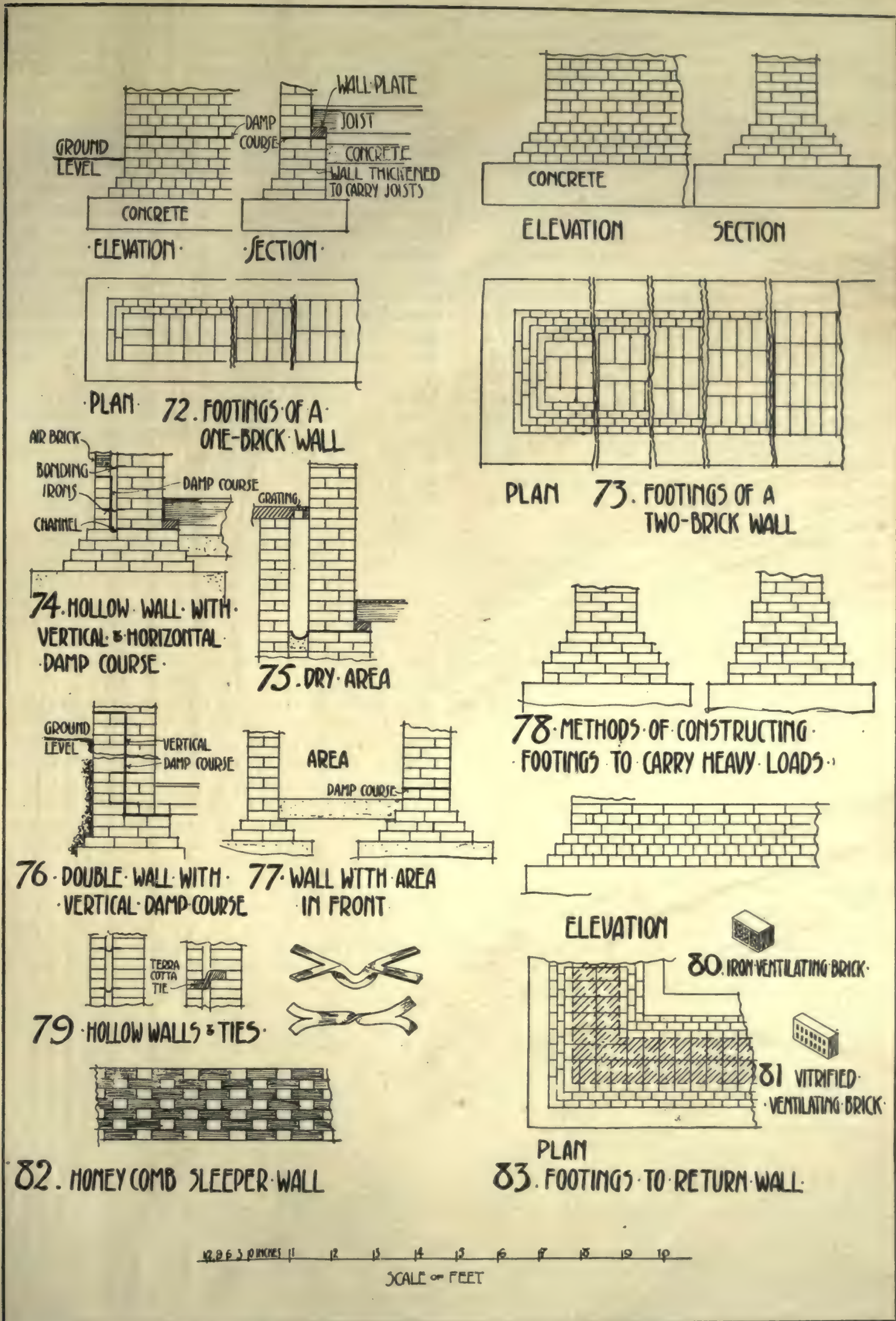
Commencing the Wall. The next course of bricks forms the *base* of the wall, and at this point a slight variation in procedure begins. The courses are no longer diminished in width, but the wall is continued upwards of the same thickness for at least several feet, and the bonding has to receive attention. Instead of setting a single angle-brick the angle of the wall is raised for several courses at a time [**84**], and is very carefully put together. Such an angle is usually formed so as to extend at the base for a length of two or three bricks in each direction, each successive course being reduced in length as required by the bond.

Plumbing the Angles. At the angle the plumb rule is used on both the front and the return face to ensure that the quoin, or angle, is perfectly vertical. The plummet consists of a straight-edge with parallel sides [**33**, p. 1951], and with a fine line or groove marked on the face. At the top are two or three fine slits, by means of which a line may be readily attached and adjusted. This line carries a heavy plummet of lead at its lower end. In using this instrument one edge is placed in contact with the wall to be tested, the face of the straight-edge is inclined slightly forward, the side being still in contact with the wall, so that the line and plummet swings out a little from the straight-edge. If, when it is allowed to swing back, it falls so as to coincide with the line, it shows the edge, and, therefore, the wall with which it is in contact, to be truly vertical; if it is not so, the bricks must be adjusted until this result is obtained on both faces. When two angles have thus been built, the line is strained through for each course, and the wall between the angles is brought up to the height to which the angles have been built, when the process is again repeated.

Building to a Fair Face. The process of forming the face of a wall carefully in this manner, so that all the exposed faces of the bricks are in an even plane, is termed building to a *fair face.* Such a length of wall is usually worked from the two ends towards the centre and from both faces, one bricklayer standing outside, the other inside, the wall, unless overhand work has to be resorted to. [See page 1171.]

Keeping Perpendiculars. Owing to the slight irregularities in the sizes of bricks, and to the possibility of slight unevenness in the thickness of vertical mortar joints, it happens, even where bond is properly formed, that unless special care be taken the vertical joints in one header course, for example, will not coincide precisely, though they will approximately, with those two, four, six or more courses below. There may be no such discrepancy as to interfere with the soundness of the wall, but its smart and workmanlike appearance is affected, and in all high-class work the bricklayer is expected to see that *perpends are truly kept* [**46**, page 2171]. This necessitates that from its base, or, at least, from any plinth course, the bricklayer must set out all openings that may occur in the upper part of the wall; where these involve forming small piers with, perhaps, the introduction of a header in alternate stretcher courses to give the required dimension to the pier. This treatment must be followed in the lower part of the wall before the window openings are reached. The closers for bonding the small intermediate piers do not appear in the unbroken wall below the level of the openings, but all other perpends should be carried down. If two successive storeys in a building are separated by a moulded string or projecting band, the line of perpends may be interrupted at such points if necessary.

Thickness of Walls and Reducing the Thickness. In constructing a high wall comprising several storeys it is not necessary to carry it up of uniform thickness throughout. In London the minimum thickness of any wall at its base and the extent to which the thickness of upper storeys may be reduced is regulated by the London Building Act, 1894, Schedule 1. The thickness at different levels depends partly upon the class of structure, partly upon the height, and partly upon the



FOOTINGS, DAMP COURSES, HOLLOW WALLS, AND TIES

length. These schedules give all necessary particulars, and though the regulations are not binding, except in London, they serve as a useful guide for reference in other districts in which such particulars are not prescribed by the local building regulations.

The external face of a wall is, as a rule, built throughout in the same plane, but where the thickness of the wall may be decreased it is done by omitting at definite stages one half-brick of the thickness [85]. Such a reduction is termed a *set-off*, and in most cases occurs on the inner face at a point where a floor is to be carried, advantage being taken of the ledge formed by the set-off to support the floor. In the case of a party wall this reduction is made on each side and amounts to 2¼ in. Sometimes, for convenience of carrying the lowest floor of a building, a set-off is required just above the base of the wall, and to form this an extra half brick is added to it at the base; but if this be done it is not necessary to increase the width of the footings; this thickening ranks merely as extra brickwork to carry the floor, and is built up so as to include in its thickness the two top courses of footings [72].

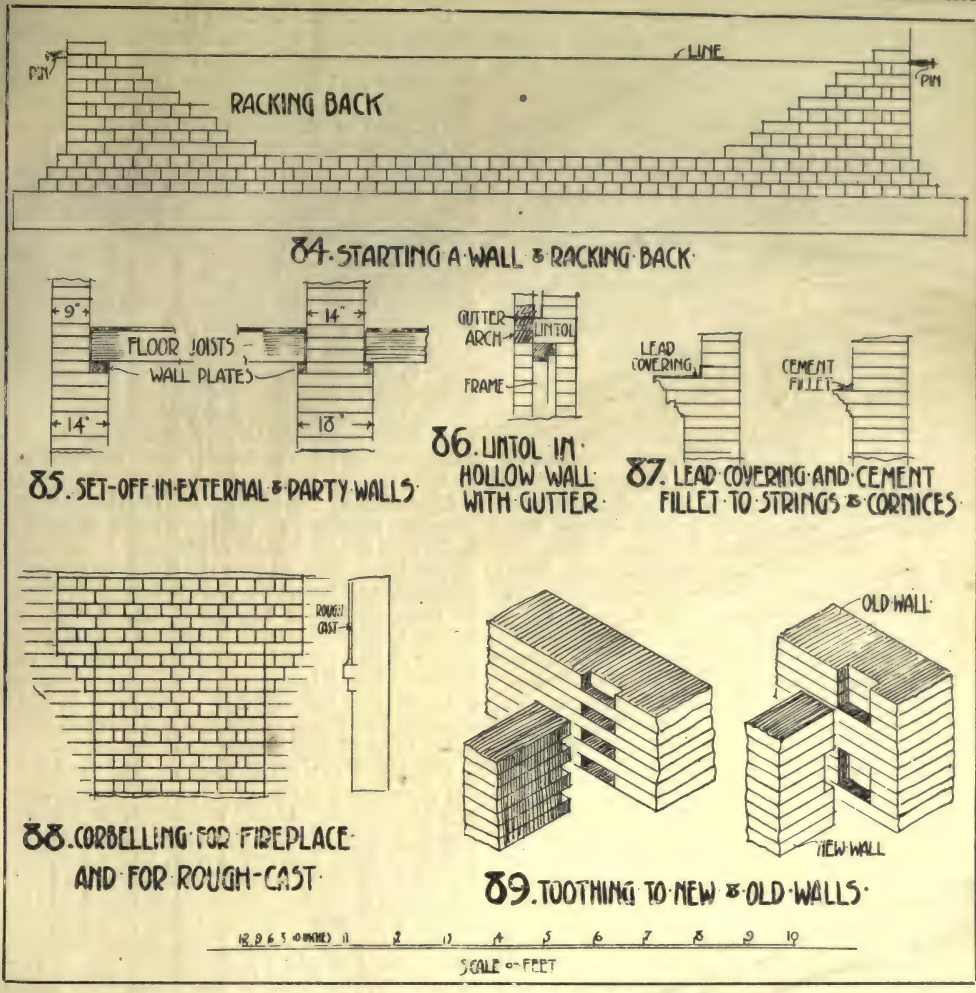
Sleeper and Fender Walls. It is often convenient and economical to form dwarf walls between the main walls to help to support the lowest floor, and such walls are termed *sleeper walls*, because they carry a wood sleeper or plate, which in turn carries the floor joists. Such walls may be a brick or half a brick thick, and will require footings. They are often formed as *honeycomb walls* [82]—*i.e.*, every course is formed, not by laying the bricks so that the ends are joined together by a mortar joint, but by merely bedding the bricks in mortar with a considerable interval between the ends; stretchers only are used. The objects of this construction are partly economy of material, but mainly the promotion of free ventilation below the floor level; such a wall is, of course, less strong than an ordinary wall, but it is amply strong for a low wall subjected only to a vertical load; it is rarely more than eight or ten courses high. *Fender walls* are usually one-brick walls built in front of a fireplace on the lowest storey, to carry the hearth-stone and the floor joists.

Damp Courses. At some point above the base of the wall and below the level of the lowest floor it is necessary to insert in all walls, including sleeper walls, a layer of impervious material to prevent moisture from rising in the walls. The footings, and perhaps the wall itself for some height, are usually in contact with the soil, and, being absorbent, will take up moisture from it; and this will, if not interrupted, tend to spread upwards and render the brickwork damp. This layer of material is termed a *damp course*, and, obviously, must, to be effective, be placed at such a level that at no point above it will the natural earth be in contact with the wall. The wall is carried up to the required height, and finished off with a level surface to receive the damp course, which may be of various materials.

Mineral Asphalt Damp Course. Probably the very best material in the British climate consists of a layer of *mineral asphalt* ½ in. thick. The only possible drawback to this material is that, if subjected to a high temperature, it may soften and ooze out under the pressure of the walls above it. It is laid in the following manner. For the best work, after the brickwork is levelled, the mortar or cement should be allowed to get fairly dry; thin slips of wood are fixed on each side of the wall, so as to stand ½ in. above the bed; the asphalt is melted in a cauldron, and becomes semi-liquid, and is then, while still hot, poured over the wall and the top is levelled; the material cools rapidly and becomes hard. It should not be laid on wet mortar, as steam is apt to be generated, and small bubbles formed. The wood edges are not always used; the material is so thick that it can be worked up to the edge as it cools without running over, but there is more liability to unevenness in thickness. One great advantage of this material is that should there be any change in the level of the damp-proof course, it may easily be worked on to the vertical surface between such different levels.

Other Damp Courses and Materials. Another excellent damp-proof course is formed of blocks of *highly-glazed terra-cotta* or *earthenware*. These are manufactured of different widths, so that in walls of moderate thickness each slab extends through the full thickness of the wall. These slabs are usually 3 in. thick, and are perforated horizontally by a series of openings so as to form a ventilating course also. They should be laid on a bed of Portland cement, mixed with a little sand, and the vertical joints formed in the same material, and should have a similar bed above them. It may be noted here that where the expense can be properly incurred it is very desirable to construct the footings and the lower part of the wall up to the damp course in cement mortar. *Sheet lead* is sometimes used as a damp course bedded in and covered by a layer of cement. One of the most usual forms, and a very economical and serviceable one, consists of two layers of good, impervious roofing slates laid on and between cement beds, and so placed that the joints in one course of slate break joint with the other course. Any of these are reliable, but care should be taken after they are laid to protect them till they are covered with brickwork. A mixture of tar and sand is sometimes used, but is liable to soften and squeeze out if the wall is exposed to sunshine even in this climate. Felt is quite unreliable as a damp course; after a time, if constantly subjected to the action of moisture, it is likely to perish.

Floors Below the Ground Level. It not infrequently happens that it is necessary to place the lowest floor of a building below the level of the ground surrounding it. When this has to be done the best course is to provide outside the wall an open area 3 ft. wide or more if possible [77], so that the wall is nowhere in contact with the surrounding earth. The level of the floor of this area must be taken down sufficiently low to bring it below the level of the



DETAILS ILLUSTRATING THE CONSTRUCTION OF WALLS

damp course. But in many cases circumstances do not permit of this treatment, and some other means must be adopted.

A *dry area* [75] is sometimes formed by building a thin outer wall 4 in. or more from the main wall; the bottom is carried down below the level of the damp course, and provided with a channel or drain to dispose of any moisture that soaks in through the outer wall; the top is covered with stone slabs or brick arching, and openings are left at intervals to provide ventilation to the space between the two walls. The outer wall may absorb moisture from the soil and become wet, but the damp cannot pass directly to the inner wall; such a narrow area is difficult of access, and not entirely satisfactory. Where no open or dry area can be formed, a damp course placed above the ground level, though it will keep the walls above dry, will not protect the lower part of the walls, and in such a case there must be a second damp course below the floor level, and provision must also be made for preventing moisture soaking into the wall between these levels.

Vertical Damp Course. A vertical damp course may be formed by covering, or *rendering*, the outer face of the wall with a layer of Portland cement and sand about an inch thick, or covering it with asphalt, which is best put on in two rather thin coats, say ⅜ in. each. A better plan still is to provide such a layer of asphalt in the thickness of the wall, where it forms a vertical damp course and is secure from any damage or interference [76]. This involves a straight joint in the thickness of the wall; but the disadvantages of this may be obviated by the use of bonding irons or ties to bind the two thicknesses together. The best method is to build one part of the wall first, building in the iron ties, which are galvanised, at intervals of 1 ft. 6 in. in every fourth course; the face of the wall is then covered with asphalt, leaving the outer end of the irons protruding from the face, and these are built in to the other

thickness of the wall as it goes up. Such a wall is perfectly sound and entirely proof against damp, even in the case where the ground is actually waterlogged, and may be used in forming storage tanks for water.

Another method is to build the two parts of this wall with a considerable cavity, say $1\frac{1}{2}$ or 2 in., and to fill in this cavity with such a material as hygienic rock, which is a damp-proof material somewhat similar to asphalt; it is filled in hot into the cavity, and is impervious. If this be done the operation should be carried out at intervals of about four courses; if the cavity be allowed to become deeper than this before it is filled in, there is some risk of air bubbles being formed in the material, which may then fail to keep out moisture.

Hollow Walls. For buildings of a small class, walls of one brick thick are allowed by law and are sufficiently strong; but they are not thick enough in an exposed situation to keep out wet if accompanied by driving wind. In some situations even a brick-and-a-half wall built in cement will hardly do so. For such positions hollow walls are frequently employed; these are formed throughout their height of two walls of brickwork, between which is a cavity varying from $1\frac{1}{2}$ in. to 3 in. [**79**]. In some rural districts walls are permitted to be built 9 in. thick in this way, the bricks being used on edge instead of flat, and built as Flemish bond, the headers forming the tie between the inner and outer skins of brick. Such a wall is ugly in appearance, but would be likely to resist the weather better than an ordinary one-brick wall. As a rule, such a wall would not be allowed in any urban district, certainly not in London, and is, in any case, only suitable for work of no great height and requiring no great strength. As a rule, a hollow wall is built with an inner thickness of at least one brick and an outer thickness of at least a half brick, and the two are bonded together at regular intervals by some special form of tie.

Wall Ties. These may be of glazed terra-cotta [**79**] or glazed earthenware, and are of such a form that the inner end is built $4\frac{1}{2}$ in. into the inner wall, corresponding in height with an ordinary brick course, while the outer end is built into the outer wall at a level one course lower down. This form is adopted to ensure that, if any water should be driven through the outer thickness and reach the bonding brick, it shall be thrown back against the outer wall and not reach the inner one. The outer end, if it be built into a half-brick wall, is made only $2\frac{1}{4}$ in. long, and will have a quarter-bat in front of it to correspond with the wall facing. A cheaper and more usual form of tie is made of galvanised iron, cast or wrought; the latter are the better. They are made with fangs at each end for building into the two walls, and the part corresponding to the hollow space is formed with a dip or twist to ensure that any water will drop from it and not pass across the tie to the inner wall.

Constructing the Hollow Wall. Such a hollow wall should start from the level of the damp course or below it and extend above the top ceiling. A channel should be provided at the bottom to carry off any water collecting in the hollow [**74**], and great care must be exercised to see that in building the walls the mortar is not allowed to drop into and choke this channel or to lodge upon the ties; it is best to have openings in the outer wall at intervals at the level of the channel so that it may have any such mortar droppings removed on the completion of the wall.

Air Bricks. Ventilation must be provided to this space by means of air bricks built at intervals into the outer wall near the bottom of it and also near the top; these are usually 9 in. by 3 in., or 9 in. by 6 in., and may be made of brick earth, with a series of perforations passing right through, to allow of the passage of air, or they may be of cast iron. In the latter case they consist of a cast iron box of the thickness of half a brick, with an external plate of iron perforated to admit air [**80** and **81**].

Openings in Hollow Walls. When openings for doors or windows occur in such a hollow wall, the hollow space may be stopped at the jamb with narrow slates set in cement; wherever the heads of timber frames or wood or concrete lintels run across the hollow, the upper surface must be protected by a small gutter of lead or zinc turned into a joint in the outer wall and long enough to project beyond both ends of the member to be protected, so that any water may be discharged into the hollow space clear of any timber [**86**].

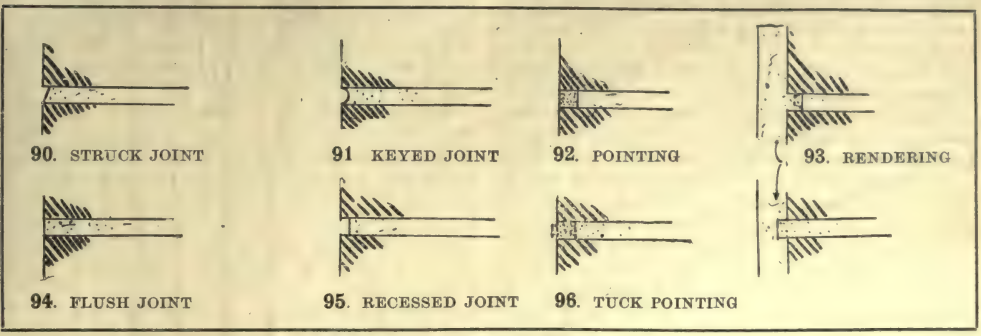
Upper Part of a Wall. In constructing a wall, the outer face is generally a perpendicular one, and is built throughout in a single plane, but there are likely to be, at certain points, various departures from this plane face. In the first place, just above the ground level, the face of this wall is sometimes set back, not by means of an offset, but by means of a moulded or splayed surface. Such a projection at the base of the wall is termed a plinth, and in a brick wall is usually $2\frac{1}{4}$ in. or $4\frac{1}{2}$ in., but sometimes much more. Their moulded face may be of brick, or of stone, or terra-cotta [**13**, page 1947; and **70**, page 2177], and, in any case, is built into the wall as the work goes up; if stone or terra-cotta be used, the course must be arranged to bond with the brickwork, as already described.

Forming String Courses. At higher points in the wall, bands of mouldings, termed string courses, may be built in so as to project beyond the face of the wall, and may be of brick, stone, or terra-cotta, arranged so as to bond with the brickwork. In addition, it usually happens that the upper surface of such a string course, if it be of brick, will be horizontal, and as there will be many joints, water is likely to lie in the top and find its way in. To obviate this, either the top is covered by a strip of lead, turned up against the wall above and into a brick joint, or the surface is covered with a layer of Portland cement mixed with sand, the upper surface of which is inclined, or *weathered*, so as to throw any water away from the wall; this is termed a *weather fillet* [**87**]. Any horizontal

upper surface of brickwork that has to be formed should be so protected.

Corbelling. It may often happen that it is desired to project a portion of the upper part of a wall beyond the lower so that its face overhangs the lower part of the wall—*e.g.*, such a projection is often formed to provide the extra thickness required to form the fireplace and flues of an upper storey. This may be done in brickwork by *corbelling* or *oversailing* [**88**], which consists in projecting successive courses of brickwork so that the face of each slightly overhangs the face of the course below—exactly reversing the arrangements of footings. No single course should project more than $2\frac{1}{4}$ in. beyond the course below it, and for many purposes a projection of $1\frac{1}{8}$ in. is more satisfactory. In the former case, four courses, and in the latter eight courses, will give a projection of 9 in.

to ensure that water shall not lie upon it and soak into it. In some buildings the top of the wall is completely covered by the roof which overhangs it, and so far as protecting the wall is concerned, no better plan is possible. But in towns such an overhanging roof is often not permissible, and the roof must finish behind the wall, or, if it covers part of the wall, a thickness equal to one brick at least, is carried up, and is termed a *parapet* [**16**, page 1949]. In either case the top must be protected so that rain falling upon it will not soak in. An inexpensive and effectual method is by forming a *tile creasing* at the top. This consists of laying on the upper surface of the wall two or more layers of hard, impervious roofing tiles so as to overhang both faces of the wall. These are laid in cement, so as to break joint, and, in fact, form a damp course at the top of the wall; they are usually finished by a



90. STRUCK JOINT **91** KEYED JOINT **92.** POINTING **93.** RENDERING
94. FLUSH JOINT **95.** RECESSED JOINT **96.** TUCK POINTING

METHODS OF FORMING BRICK JOINTS

In cases where the upper part of a wall is to be rough cast or hung with tiles, the lower part of this wall is usually finished with two or more courses of corbelling so as to throw out the lower edge of the tiling or rough cast [**88**]. Such a corbel course may be formed of plain or moulded bricks, or of a mixture of plain and moulded bricks. Where each course projects $2\frac{1}{4}$ in., it is desirable to use header bond, but with a projection of $1\frac{1}{8}$ in. stretcher courses may be used.

Cornices. Sometimes at or near the top of a wall a large and elaborate group of mouldings is corbelled out from its face, and in this position the term *cornice* is given to such a feature, which is an architectural enrichment, and not essential to the structure [**87**]. Such a cornice may be formed of brick, and will include courses of plain as well as moulded, and very possibly enriched bricks. When formed of such small material, great care is required in putting together such a cornice, the corbelling out of which must be carefully done. The upper surface must be protected by leadwork or cement, and the wall is often carried up beyond the top of the cornice, forming a blocking course, to counteract the tendency of such a feature to overbalance. Any cornice of brick must be designed to be of only a moderate projection, and cannot overhang to the extent that is possible with one formed of long stones.

Protecting the Top of a Wall. The top of any wall requires some special care

course of plain or bull-nose or half-round bricks set on edge and built in cement. Such a course of bricks forming the termination of a wall is termed a *coping course.*

Special Copings. For rather better work brick or terra-cotta copings of special design [**17**, page 1949] are made in large blocks so as to reduce the number of joints, and so as to overhang both faces of the wall, and a hollow should be formed in the under surface of such a coping block on both sides of the wall, so that any water running from the upper surface shall drip from the edge of the coping and fall clear of the wall, and not drip down the face of it; such a hollow is called a *throat.*

Copings are made in a great variety of forms and widths to suit different styles of architectural treatment and individual tastes. In some the water is thrown off one edge of this coping, which is then styled a *weathered coping;* or, if a plain surface be formed to throw the water off both edges, it is termed a *saddle-back coping,* and others are termed *moulded copings.*

Finish to Ramps and Sloping Surfaces. A curved surface forming the top of a wall in such a feature as a ramp must have the bricks cut to the required form, but is usually finished with a coping of brick on edge which, if the curves are sharp, must be axed. This is to avoid finishing the top of a wall with small pieces of cut brick, which would easily be displaced, and the cut surfaces of which would be

particularly liable to absorb moisture. Where the width of an external feature, such as a chimney stack, requires to be reduced, simple offsets are both ugly and unsuitable, and such reductions may be made by forming a double slope across the thickness of the wall with a small gable covered with tiling or a coping, or by a single slope finished by what is described as *tumbling;* this consists of a series of brick courses set at right angles to the slope, and the lower surfaces cut to fit on to a horizontal bed, the object being, as in the case of a ramp, to show only whole bricks on the exposed surface.

Effect of Heat on Brickwork. If brickwork be executed in very dry or hot weather the bricks themselves will be dry; if laid in this condition they are likely to absorb the water from the mortar to such an extent as to interfere with the action of setting, and at such times the bricks should be well wetted before use. This is best done with a hose before they are carried to the scaffold.

Effect of Frost on Brickwork. Brickwork in mortar should not be executed during the prevalence of frosty weather, the danger being that the water in the mortar will be liable to freeze. In Norway it is held that with due precautions brickwork may be safely carried on when the thermometer stands at 14° to 18° F., and even when it is as low as 0° F., but that it ceases to be economical when the temperature is below about 14° F.

At these temperatures work is executed with mortar mixed with quite freshly-slaked lime made in small quantities and used while still hot, and the proportion of lime is increased as the temperature becomes lower, so that setting may take place before freezing. The bricks must be quite dry when used. Bricks exposed to rain or frost must not be employed, and after any temporary stoppage of work the top of any piece of brickwork must be cleared of any ice or snow before work proceeds. When the frost is not severe, work may usually be carried on in cases where a quick-setting cement is used.

The top of a wall may be protected during frosty weather by covering it with felt or sacks and boards; the mortar joints may be affected for some little distance into the wall, and must be then raked out and pointed, but if the damage extends far into the wall the only remedy is to take down and reinstate the work.

Finishing Mortar Joints. The mortar joints on the face of the wall may be finished in various ways, but they are rarely left just as they are formed in laying the bricks. If the surface of the wall is to be plastered or rendered [93], the mortar in both horizontal and vertical joints is raked out for a depth of about ⅜ in.; this is to give a better hold or *key* to the plaster. If the face of the wall is to remain exposed, the joints are carefully finished, and this process greatly improves the appearance of the brickwork. If the weather be suitable, this may be executed as the work proceeds, and the joints are then said to be *struck* [90]; if the work is of such a nature that it can be completed in this way without fear of frost, it gives good results Where frosts may be expected to occur before the walling is complete, it is usual to rake out the joints to a depth of about ¾ in. as the wall is built, and to finish the whole face of the wall when completed, and this process is termed *pointing* [92]; it involves reinstating the stages on the scaffold to carry out the work better than is necessary for merely making good the putlog holes, and the work must be well wetted before pointing. In the case of old walls, in which the mortar joints show signs of decay on the surface, this method is always employed.

The actual finish of the face may be made in a variety of ways, and many of these may be used whether the joints are struck or pointed. The joints are actually formed with the trowel. A special small trowel is sometimes used, and a long straight-edge.

Flat, or Flush Joints. *Flat,* or *flush* joints [94] are those in which the mortar is flush with the face of the wall and vertical; this is sometimes varied by leaving a line drawn along the centre of the joints by means of an iron jointer.

Struck Joints. *Struck* joints [90] are formed with an inclined face; the lower edge is flush with the brick below and is struck with the trowel and straight-edge; the upper edge is pressed back so that any water dripping from the brick above will be thrown off by this surface on to the face of the brick below; this form of joint is sometimes described as a *weathered joint.*

Keyed joints [91] are formed by drawing a rounded iron along the centre of a flush joint, giving it a hollow section.

A *recessed* joint [95] is formed by setting back the face of the mortar behind the face of the brick; but this is not so good a protection to the wall as a weathered joint.

Tuck pointing [96] is generally used to conceal the defects of inferior work. The joint is filled flush with mortar; the wall is then rubbed down with a soft brick, so that the bricks and mortar are of a uniform colour, or a wash of ochre is sometimes applied; finally, a fine line of white putty is worked on to the centre of the surface of the joint, so as to give the appearance of gauged work.

Forming Toothings. If for any reason a cross-wall cannot be built at the same time as the main wall from which it starts, a *toothing* is formed in the main wall—*i.e.*, in every alternate course a recess the full width of the cross-wall and 2¼ in. deep is formed by building in the closers used to bind the cross-wall only. This allows of the cross-wall being properly bonded to the main wall when it is built, but unless the walls are built in cement the main wall will have settled down slightly before the cross-wall is erected, and this, too, when built will in time settle down also, and a fracture at the joint may result.

If a new wall has to be bonded to an old one it is usual to cut out toothings the full thickness of the new wall three or four courses high, and penetrating 4½ inches into the old wall, and to build the new work into them.

Continued

STOCK-IN-TRADE

Analysing Transactions. Obtaining Goods on Credit. The Invoice Guard Book. How to Use It. Filing Invoices. Trading A/c. Goods A/c

Group 7

CLERKSHIP

16

Continued from page 2204

By A. J. WINDUS

ALL systems of accounting have for their common object the recording and classifying of transactions, and this is equally true of single-entry as of double-entry methods. In double-entry, analysis and synthesis are the vital processes, but in single-entry systems analysis is not an active principle but an accidental circumstance, and therefore any classification obtained by single entry is seriously defective.

By synthesis is meant firstly the building up of items into accounts, and lastly the consolidation of open accounts into a few great classes in the Balance Sheet. There are also intermediate stages which will claim our attention.

What We Understand by Analysis. By analysis we understand the resolving of transactions, accounts, items, totals, into their constituent parts for the purpose of forming fresh combinations or of deducing other information than what appears on the surface. Thus, the total of the "Paid" column of the petty cash book, at page 403, is broken up into various sub-totals, so that in place of one set of figures amounting to £89 13s. 11d. we have six new sets or combinations to deal with. Again, in double-entry systems, to register a transaction it is necessary to analyse it—that is, to discover the debit and credit elements of which it is composed—before entering it in a specialised book of original entry or in the journal.

Goods Bought on Credit. In single entry, however, this rule is "more honoured in the breach than in the observance," for we usually find but one aspect of a transaction noted. Thus, where goods are bought on credit some persons adopt the free and easy method of making entries straight from the invoices to the creditors' accounts in the ledger, and imagine that a saving of time is effected thereby. But if short cuts are to constitute the sole test of merit in bookkeeping, then the most summary way of dealing with the matter would also be the best—namely, to refrain from opening any accounts at all with creditors. As the monthly statements arrived they would be compared with the invoices already passed, and, if correct, cheques or cash would be remitted in settlement; if incorrect, explanations would be asked for.

Everyone knows that, were such a course adopted, two of the principal objects of bookkeeping—to furnish information as to the financial condition of a business, and also with regard to its progress—would be defeated. Few single-entry bookkeepers go to this extreme, and yet the methods of the rest are scarcely more efficacious in tracking the *progress* of an undertaking than the policy of inaction pursued by the minority.

The Invoice Guard Book. Many single-entry bookkeepers use an invoice guard book similar to the order guard book [described on page 776], as the medium for posting invoices to the ledger; but all of them stop short of double entry, which is frequently confounded with double posting—it being supposed that every invoice must first be posted to a creditor's account, and then to some other account, so that if there were two hundred invoices there would be four hundred postings. Of course, the only thing necessary to complete the double entry here is to ascertain the grand total of the invoices as posted from the guard book, or from the invoice journal, and to post this total to the debit of some account in the ledger representing goods.

There is one objection to the use of guard books which might easily be removed, since it grows out of the absurd practice of crowding the invoices due to an exaggerated sense of the value of space. It is usual to secure invoices in the guard book by means of "stickphast," gum, or some other adhesive substance, and to fold them to a uniform size in much the same way as letters received are folded for filing away in pigeon-holes. Thus, from half a dozen to a dozen invoices may be accommodated on a single page of the album; but the irritation and loss of time occasioned by having to unfold invoices when required for reference outweigh the paltry economy of space achieved.

How the Guard Book Should Be Used. It has been sought to mitigate the annoyance by endorsing upon the outside of each invoice certain particulars as date, name of creditor, and amount, but although this plan facilitates reference it entails labour which might be avoided. The remedy consists in fixing the invoices into the guard book and leaving them unfolded, the second invoice being placed immediately below the first or on the next page, should the first happen to take up too much room to allow of a second being affixed beneath it. The third invoice would follow the second, and so on. The guard book would have to be renewed more often under this plan than under the old method, but a book of 500 or 1,000 pages would be ample for a year's invoices in the majority of cases. Moreover, where the books are kept by double entry and an invoice journal as well as a guard book is used, the invoices in the latter may be so arranged as to overlap one another, but

without interfering to any appreciable extent with ease of reference. In such a case, only the lower border of the back of each invoice is gummed to the guard book, the second invoice being affixed at a sufficient distance below the line of adhesion of the first to ensure that the unattached portion does not cover up the *heading* of the invoice which it overlaps.

Filing Invoices in Guard Book. Invoices are filed in the guard book in alphabetical order at weekly or other intervals, and from thence are entered into the invoice journal. On each invoice is noted in red ink or blue pencil—black ink does not show up well—the folio of the invoice journal on which it is entered, and in the journal is noted either the page of the guard book where the invoice itself is to be found or the serial number given to the invoice upon its being passed for filing and entry.

The using of a guard book without an invoice journal is not necessarily incompatible with the principles of double entry. In some wholesale houses the guard book is elevated to the dignity of a journal. On every page a money column is provided into which the invoice amounts are extended, each amount being exactly opposite the total of the invoice to which it relates. The various invoices are posted separately from the guard book to the ledger, and the double entry is completed by posting the total of the money column to purchases account in the ledger.

By reserving a separate guard book for each department of a business a second and closer analysis of the transactions represented by the invoices is effected. In lieu of one grand total for purchases during a given period, we obtain as many guard book totals as there are departments; and the information will be of service when inquiry is made as to which departments are responsible for profits, and which for losses, and the extent to which the different departments have contributed thereto.

Where but one invoice journal or guard book is kept for all departments the analysis in the first instance merely resolves the invoice transactions into their debit and credit elements, there being one debit to purchases account (or goods account) as against a number of credits to the sellers of the goods.

Analysis Columns in the Invoice Journal. To distribute purchases over the various departments of a business, so that each department shall be charged with the goods it receives into stock, the original analysis must be supplemented by a further dissection, for which purpose analysis columns, similar to those in the analysis petty cash book, are sometimes inserted in the invoice journal, each column being headed with the name or number of a department. In other instances, dissection sheets are resorted to. These will be explained in due course.

It is doubtful whether, in view of the modern tendency to discard bound books in favour of loose-leaf books, card systems, and the like, the guard book will long survive the attacks made upon it. It has, however, justified its title by guarding the documents entrusted to its keeping, and while capable of improvement in some respects, it excels in others.

Trading Account. Students may find it useful to refer to our previous remarks upon the treatment of invoices [see page 977], after which let us consider the following transactions as they appear in the synopsis at pages 1750 and 1751—namely, (*c*) to (*g*) inclusive, (*t*) and (*u*). It will be observed that they all relate to goods, some to purchases—(*c*) and (*t*)—some to sales—(*d*), (*e*), (*f*), (*g*)—and one to returns (*u*). Formerly, bookkeepers recognised no other classification for such transactions than that of "goods" or "merchandise," but the normal development of the analytic method has changed all that, and the primitive goods account is now broken up into several sub-accounts, which are periodically united under the title of Trading account.

This departure from ancient custom indicates that the old method has been tried and found wanting. Let us see why the Goods account stands condemned at the present day. The theory upon which it was constructed was simple enough, and was derived from the fact that the chief business of a trading concern is to buy goods and to sell them at a profit. It was argued with some show of reason that if one account were opened, and debited with all goods coming in and credited by all goods going out during a given period, and if at the end of that period this account were also credited or discharged by the value of the unsold goods or stock on hand (if any) *at cost prices or under*, and a balance struck, then the amount by which the credit side of the account exceeded the debit side would represent profit—not ultimate or *net* profit after all expenses had been paid, but great or *gross* profit on the goods actually sold, minus any loss which had occurred by depreciation of the goods remaining unsold. In like manner, the amount by which the debit side of the account exceeded the credit side would represent loss—not final loss after all expenses had been paid, but the initial loss on the goods actually sold, plus any loss which had occurred by depreciation of the goods remaining unsold. Depreciation, it may be added, has to be reckoned with whenever stock is become shopworn, unfashionable, or obsolete, or whenever it has suffered damage or deterioration such as renders it unsalable except below cost, when it may truthfully be said to be offered "at a sacrifice." In the latter case, the probable extent of the loss when the goods are sold will be the measure of depreciation in the stock of those particular goods.

The Goods Account. The proof relied upon by the old-time bookkeepers to establish the foregoing theory will now be given, and its limitations explained. This will enable us to understand why the goods account has been discarded by the modern accountant.

Mr. Andrew Crawford, of Liverpool, is the patentee of a portable heating and cooking apparatus which he desires to introduce to the public under the trade name of the "Triumph" oil-stove. He decides not to risk his capital in building a factory and in laying down a suitable

plant for making stoves of this description until evidence is forthcoming that the article has obtained a firm hold upon the public favour. No surer testimony to the existence of a genuine demand for an article can be found than that supplied by the steady increase in the sales of that article, season by season and year by year, and this is the evidence Mr. Crawford requires before embarking upon a course of action which would necessitate a large outlay of capital.

But if he will not make the stoves himself he must procure someone to make them for him. He therefore enters into negotiations with the Birmingham firm of Jones, Price & Co., hardware manufacturers, who undertake to supply his wants upon mutually satisfactory terms. The contract between the parties as finally drafted provides, among other things, (*a*) that Messrs. Jones, Price & Co. shall manufacture "Triumph" stoves exclusively for the patentee and to his specification; (*b*) that the patentee shall order from the manufacturers a minimum number of such stoves during the currency of the contract—that is to say, within a period of three years from its initiation—and shall have the right to order as many stoves above such minimum number as he shall require; (*c*) that a fortnightly delivery of stoves to the patentee shall be made at the rate of not less than a specified number per annum; (*d*) that the price per stove delivered at the patentee's warehouse in North John Street, Liverpool, shall be 8s. 6d. for size A, and 11s. 4d. for size B; (*e*) that statements of account shall be rendered monthly, and that same shall be subject to 3¾ per cent. cash discount if paid within 10 days from the date thereof.

Gross and Net Profits. So far, then, as goods coming in are concerned, Mr. Crawford is in the position of a wholesaler, but he has now to make up his mind whether he will attempt to reach the public direct or through the retailer. If he decides in favour of the latter, and perhaps the wiser alternative, he will have to be content with a somewhat smaller rate of gross profit, because the retailer is also entitled to a profit, and usually obtains a higher percentage of profit than the wholesaler. If "Triumph" stoves were offered to the public at exorbitant prices, there would be an abatement, or possibly a total cessation, in the demand for them. Generally speaking, a small turnover with a high rate of gross profit is not so good as a larger turnover with a lower rate of profit. Take the case of a retailer who has been making 33⅓ per cent. "on returns"—that is to say, on an average the cost price of each £150 worth of goods sold is £100. On sales amounting to £3,000 the gross profit would be one-third of that sum, or £1,000.

Let us assume that the conditions were such that the profit of £1,000 provided a sufficient margin out of which to pay fixed expenses, or establishment charges, as rent, salaries, trade expenses, and the rest. The residue, after the whole of these expenses had been met, would be styled "net profit," and would belong to the proprietor.

Reduced Rate of Profit. Suppose, now, that the retailer determined to make a bid for an increased volume of business by lowering his prices somewhat, so that, instead of securing on an average 33⅓ per cent. gross profit, he obtained 25 per cent. only, and that, largely owing to this stimulus, the second year's turnover was double that of the first year. What has happened? In the first place the sales have grown from £3,000 to £6,000, and the gross profit from £1,000 to £1,500. But it may be asked: "Is not this additional £500 swallowed up in extra expenses?" Not unless there has been mismanagement or dishonesty. It is a law of business—the persistent violation of which invariably ends in disaster—that establishment charges must increase at a smaller ratio than the sales in respect of which they have been incurred. On this basis it is clear that, allowing for a slight natural increase in the fixed expenses, due to an increase in the sales and to other causes, the retailer would still be better off when he was getting 25 per cent. on a turnover of £6,000 than when he was earning a higher rate on a lesser volume of business.

During the first year of his contract Mr. Crawford took delivery of 5,732 A "Triumphs" at 8s. 6d., and 1,476 B "Triumphs" at 11s. 4d. His credit sales throughout the same period were 5,432 A stoves at 10s., 1,419 B stoves at 13s. 4d.; 217 A stoves and 140 B stoves were, however, returned by customers for various

Dr	Goods a/c (No 2)					Contra					Cr
1902 Dec 31	To Sundries (purch.)		3272	10		1902 Dec 31	By Sundries (sales)		3662	·	·
	" Do (returns inwards)		201	16	8		" Do (returns outwards)		40	16	·
	" Balance being Gross Profit tfd to Profit & Loss a/c		519	·	6		" Stock on hand (at cost)	c/d	290	11	2
			£3993	7	2				£3993	7	2
1903 Jan 1	To Stock	b/d	290	11	2						

reasons, and 79 stoves (28 A and 51 B) were sent back to the factory as being defective. There were no cash sales. With these facts before us we can exhibit the goods account in an abbreviated form, but it should be borne in mind that the account here given is not a copy, but a summary of the account in Mr. Crawford's ledger.

The goods account is here shown in condensed form, but Mr. Crawford has adopted the detailed form which, at much greater length, supplies less real information. For every purchase, a journal entry is made debiting goods account and crediting Jones, Price & Co., and for every sale the customer is debited and goods account credited. Conversely, for returns to factory (returns outward), J. P. & Co.'s account is debited and goods account credited; for returns from a customer (returns inwards) goods account is debited and the customer's account credited. This is double entry with a vengeance! The number of items on the credit side of goods account may be gauged from the fact that in the first year of trading 249 accounts have been opened with retail ironmongers and others. Furthermore, a great many customers have sent "repeat" orders, so that there are probably not less than six or seven hundred postings to goods account on the credit side alone. The debit side is briefer, since it relates chiefly to purchases from Jones, Price & Co., who despatch and invoice goods to Crawford fortnightly, as per contract.

In a goods account built up item by item, not only are time and space squandered as the direct result of the method employed, but the account itself is perplexing, because it fails to discriminate between purchases and returns inwards on the one side, and between sales and returns outwards on the other. Omitting dates and journal folios, the goods account in Mr. Crawford's ledger would be set out as below.

Dr.	Goods a/c (No 1)						Contra				Cr.
	To J. P. & Co.		113	6	8		By Clements & Son		5	13	4
	" Hugh Bros.		2	6	8		" Thos. Ballard		5		
	" J. P. & Co.		113	6	8		" J. P. & Co.		2	5	4
	" &c						" Hugh Bros.		2	6	8
	" &c						" E. W. Langford		5	10	·
	" &c						" E. W. Wilson & Sons Ld		5	16	8
	" Balance, being Gross Profit transferred to P & L a/c		519	·	6		" Alfred Gill		1	·	·
							" &c				
							" &c				
							" Stock on hand (at cost)	c/d	290	11	2
			£3993	7	2				£3993	7	2
1903 Jan 1	To Stock	b/d	290	11	2						

Comparing this with the former goods account, marked No. 2, we observe that, despite variations in structure, the two accounts agree as to the amount of profit balance, and as to the amount of stock in hand. But the goods account has not fulfilled its office by merely disclosing the value of the stock in hand and the amount of gross profit earned; we wish also to know the *rate* of gross profit, the number and selling value of stoves sold in each month, the number returned, the total sales and purchases for the year, the ratio of returns to sales, and other useful facts about the business which are capable of being elucidated by means of the figures contained in the goods account. It thus appears that the *form* of the goods account is a matter of importance, because to be of service the information stored up in that account should be always accessible. It is a step in the right direction when specialised books of original entry are substituted for the journal, the monthly totals only of purchases and returns inwards, sales and returns outwards, being passed through the journal and posted to the goods account.

Continued

THE PRESENT & FUTURE OF TRANSIT

Public Service Automobiles. Electric Traction. Water Transit. The Marine Turbine. The Problems of Air Transit. Submarine Boats

By F. L. RAWSON

NATURALLY the principle of the automobile has been applied to omnibuses for public traffic, and strenuous efforts have been made to arrive at a satisfactory design for such vehicles. Hitherto, although a fair measure of success has been attained, it cannot be said that the difficulties have been overcome. One of the principal troubles is the cost of tyres, which amounts to 2d. per car-mile on the average—a very serious item. Many motor-'bus services have already been put in operation, although the Royal Commission on London Traffic, which reported last year (1905), did not consider that the vehicle offered a solution to the problem of rapid transit, in its present stage of evolution.

The Motor-'bus. Undoubtedly the motor-'bus will be developed into a practical and commercial success, and will in time displace the great majority of the horse-drawn 'buses at present plying in the streets. Unlike the electric tramcar, its chief rival, the motor-'bus can thread its way in and out through traffic, and is thus enabled to compete in speed with the former. Its carrying capacity (34 seats) is about half that of the tramcar, so that twice as many 'buses are needed to cope with a given traffic; but it has the great advantage that it is not tied to a fixed route, and is free from the heavy burden of capital and maintenance charges due to the costly track required for the tramcar. There is no doubt that in sparsely populated districts, where the traffic would not justify the expense of a tramway, the motor-'bus will be, and indeed already is, a most valuable means of transit; as a feeder to tramways and branch railways, it will be almost indispensable.

Prepared Tracks. Obviously the use of a carefully-prepared track for the wheels of carriages and waggons greatly facilitates progression, and, in places where traffic was particularly heavy or the gradients severe, slabs of stone, wood, or iron were laid down many years ago to secure this advantage. From this custom arose the modern tramway, or street railway, in which steel rails are laid flush with the street surface, and the vehicles are provided with flanged wheels suitable for running thereon without liability to become derailed. In order to prevent the road material from clogging the flanges and hindering progress, or throwing the wheels off the rail, the latter is provided with a lip, forming with the head of the rail the so-called groove. On such a tramway heavy vehicles can be hauled with ease, and as tramways are almost invariably employed for public service only, the vehicles are arranged to accommodate as many passengers as possible.

Horse Tramways. In the great majority of foreign countries the cars consist of a covered platform carrying a series of seats, providing sitting accommodation for from 20 to 30 passengers; in Great Britain, on the other hand, it is the usual custom to add a second tier, or deck, to which access is gained by a staircase, and the seating accommodation is thus raised to about 40 passengers. The smaller cars are sometimes hauled by a single horse or mule, but two are required to propel the larger cars, which weigh four or five tons each when empty. On horse tramways through urban districts a speed of about six miles an hour is maintained, including stops, and the charge made is usually about 1d. per mile; this sum, however, leaves very little margin for profit—sometimes none at all.

Power-driven Vehicles. For this reason continual attempts have been made to substitute a more economical means of haulage than horses. Cars hauled by small steam locomotives have been used in many places, while gas power and compressed air have also been tried, but without much success.

Cable Traction. In districts where the traffic is very dense and continuous it has been found practicable to haul the cars by means of an endless cable, traversing the whole length of the line, and running in a conduit beneath the roadway. Connection is made with the cable by means of grippers, which pass through a slot in the surface of the roadway, and can be attached or removed when desired. The advance of the times, however, has led to the abandonment of this expensive system in the great majority of cases in favour of the use of electricity as the propelling agent. Cable traction is valuable on steep hills.

Electric Tramways. Seeing that electric power has been proved the most economical, as well as the most convenient and efficient, of all mechanical tractive agents, it is unnecessary to dwell upon its forerunners. There were in November 1905, 3,100 miles of single tramway track in this country worked by electricity; almost the whole of these are operated by means of the overhead conductor system, the only exceptions being found in London, Bournemouth, Lincoln, and Wolverhampton.

In London, the County Council has equipped 26 miles of double track with the underground conduit system; in Bournemouth the corporation has adopted the same system for a length of one mile in the centre of the town, and in Wolverhampton the town council has utilised the Lorain surface-contact system, in which the

cars obtain their supply of electrical energy through metal blocks laid in the street surface, projecting slightly above the latter, and connected with the electric underground cables only while the car is actually over the charged contact studs. Another surface-contact system, called the Dolter system, is about to be laid down in Torquay, and a third, the G. B. system, has just been installed in Lincoln. Obviously, however, the overhead ystem is the most popular, as it is also by far the cheapest to instal, and even where other systems have been used, as in London and Wolverhampton, extensions are being carried out on the overhead system.

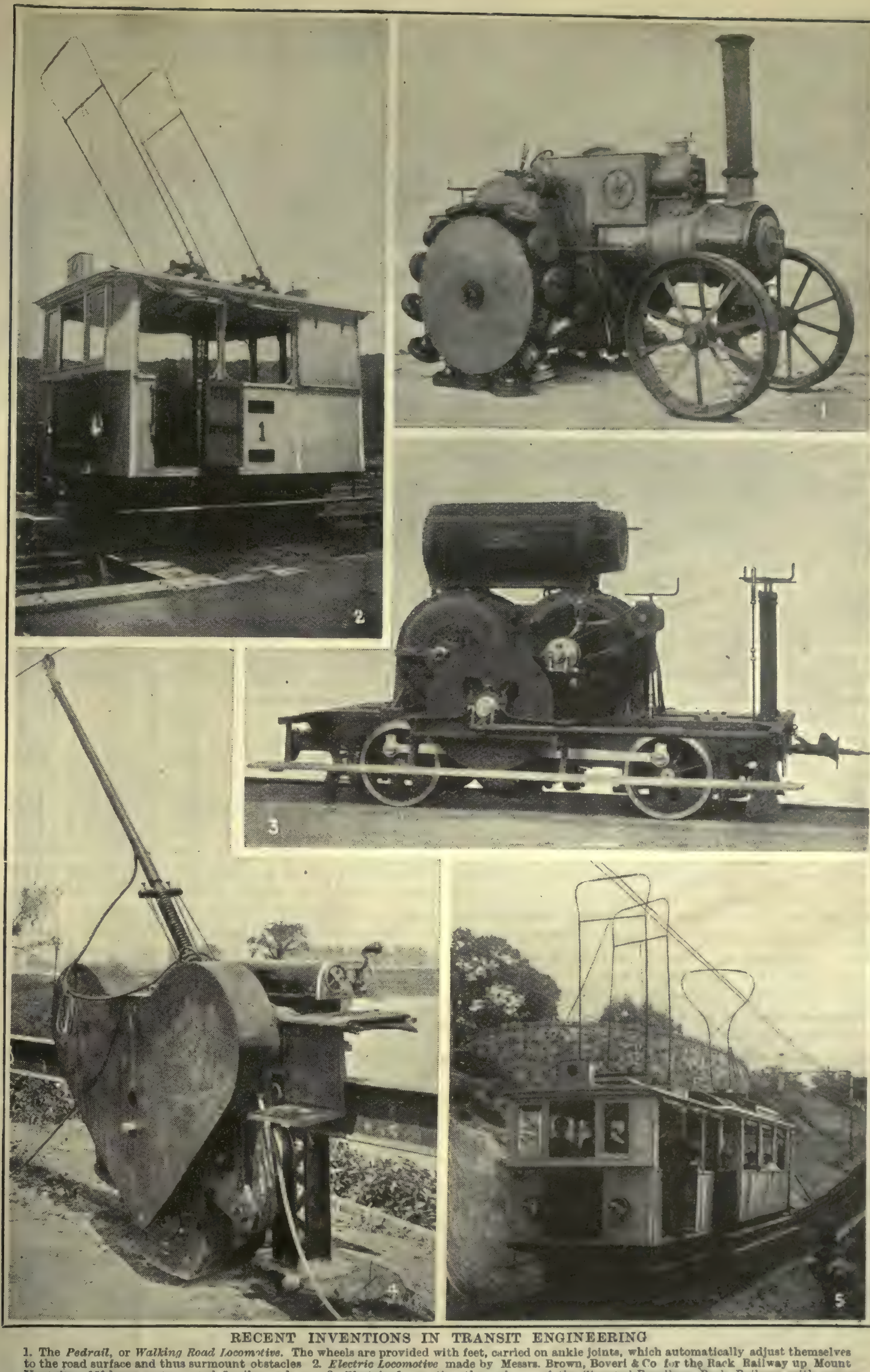
Cost of Electric Traction. The average cost of electric traction—to the passenger—is about ½d. per mile. The speed depends upon local regulations, being generally from 8 to 12 miles per hour, including stops. In some cases, however, a speed of 14 to 16 miles per hour is allowed, and on private right-of-way the speed is limited only by considerations of safety and economy, though not usually exceeding 25 to 30 miles an hour. In America the tramways have undergone greater development than in this country, extending for many miles round and between most of the large towns; adjacent tramway systems have been linked up to form huge networks, extending sometimes for literally hundreds of miles, and very high speeds are maintained on the inter-urban lines, often reaching 50 or 60 miles per hour.

In this country the tramways are largely in the hands of the local authorities, and some of them have attained very considerable dimensions; for example, the Corporation of Manchester owns or works 150 miles of single track; Glasgow controls 147 miles, and Liverpool 103 miles. Complete through communication has been effected between many large towns, such as Leeds and Bradford, Liverpool and Bolton, Glasgow and Paisley. Naturally, the competition has reacted detrimentally upon the railway suburban traffic in many cases, in some of which the railway company has had to adopt electrical traction, while in at least one other the suburban railway service has been totally discontinued. An enormous traffic is carried on the tramways; for example, the population of Liverpool was carried 167 times over last year, that of Manchester 169 times, and that of Glasgow 196 times.

Electric versus Steam Traction. In spite of the encroachments of electricity upon the preserves of the steam locomotive, the latter still easily holds its own in the sphere of long-distance transit, and is likely to do so for many years to come. Electric traction has the great advantage that almost unlimited power can be applied to a car or train, so as to accelerate the latter very quickly, while it is also possible, with electricity, in the act of stopping, to recover a considerable proportion of the energy stored up in the moving mass. Thus, electric traction is pre-eminently adapted to cases where a frequent service is necessary, with numerous stops, conditions which are met with in urban and suburban traffic, but not at all in the case of long-distance journeys. For the latter heavy trains run at long intervals are more suitable, for the maintenance of a frequent service of stopping trains, which are necessarily slow trains, would absolutely cripple a main line express service on the same line of rails. Moreover, the cost of the complete conversion of a long line to electrical working, entailing the reconstruction of the rolling-stock and the reorganisation of the whole system of running, is at present prohibitive. Consequently, though electrical science has now made such progress that long-distance service is perfectly feasible from an engineering standpoint, it is impracticable from the commercial point of view. Progress in this direction must come by stages. In the meantime steam remains supreme.

Steam Railways. The British railway system as a whole is unsurpassed throughout the world for speed and safety; it consists of about 36,000 miles of single track, on which the average traffic is exceedingly dense. On the basis of gross receipts, the passenger traffic constitutes 43 per cent., and the goods and mineral traffic 57 per cent. of the total; the average gross receipts per mile of single track open for traffic amount to £3,100 per annum, but the traffic varies enormously, according to local conditions. For instance, the receipts per mile of track on the Central London (Electric) Railway amount to no less than £50,000 per annum, entirely passenger traffic, although the average charge is only about ½d. per mile. Owing to the constant increase in the traffic, the tendency for many years has been towards longer and heavier trains, entailing the construction of enormously powerful locomotives. It is not uncommon for a locomotive with its tender to weigh 100 tons or more, and mineral trainloads of nearly 2,000 tons are met with. In America the latter reach 3,000 tons. The adoption of corridor coaches, while greatly increasing the comfort of passengers, has also increased enormously the ratio of the deadweight to the paying weight carried, from something like 4 cwt. per passenger to 14 cwt. The average speed attained is about 30 miles per hour; express trains commonly reach 50 miles per hour, including stops, and some long-distance runs of nearly 200 miles are regularly covered at the rate of 55 miles an hour, involving the occasional attainment of speeds of 70 to 80 miles per hour. It is not likely that any material advance on these speeds will be effected with steam propulsion, but electric trains have been run experimentally at as high a rate as 130 miles an hour.

Goods and mineral trains, of course, travel at much lower rates, from 15 to 25 miles per hour. The great difficulty met with in connection with goods traffic in this country is the extremely varied character and the small quantities of the goods despatched. The average load of a 10-ton waggon is only 2 tons; the bulk of the consignments do not weigh more than 1 ton each, and an enormous number amount to only



RECENT INVENTIONS IN TRANSIT ENGINEERING

1. The *Pedrail*, or *Walking Road Locomotive.* The wheels are provided with feet, carried on ankle joints, which automatically adjust themselves to the road surface and thus surmount obstacles 2. *Electric Locomotive* made by Messrs. Brown, Boveri & Co for the Rack Railway up Mount Vesuvius; 150-horse power, speed 5 miles an hour 3. *Electric Locomotive* (three-phase) of the Stanstad-Engelberg Rack Railway, with cover removed showing induction motors 4. *Electric Tractor* for hauling canal boats. It runs on the girder shown, and takes its current from the overhead wire 5. Vesuvius Rack Railway Tram

1 cwt. Is it to be wondered at, then, that the cost of carriage within the British Isles is very high? The cost of goods transport by rail is studied in another part of the SELF-EDUCATOR.

Railway Maintenance. The standard rate of charge for passengers per mile is 1d., but, owing to many causes, such as the carriage of workmen at low rates, the reduced fares for excursions, etc., the actual receipts do not, on the average, approach this figure. The working costs have risen of recent years, and now constitute about 63 per cent. of the receipts, leaving but a small margin for profit after paying interest, depreciation, etc. The average dividend paid on the ordinary capital is only $3\frac{1}{4}$ per cent.

The excessive cost of running an ordinary train service on branch lines where there is but little passenger traffic has led to the adoption during the past few years of motor-cars on railways. These consist of single coaches, each of which is provided with its own propelling agency in the form of a steam or petrol engine in various modifications. By means of such cars it is possible to maintain with profit a fairly frequent service on a line that would otherwise prove unremunerative, while greatly benefiting the population of the surrounding district. The movement is still in its infancy, but is rapidly extending.

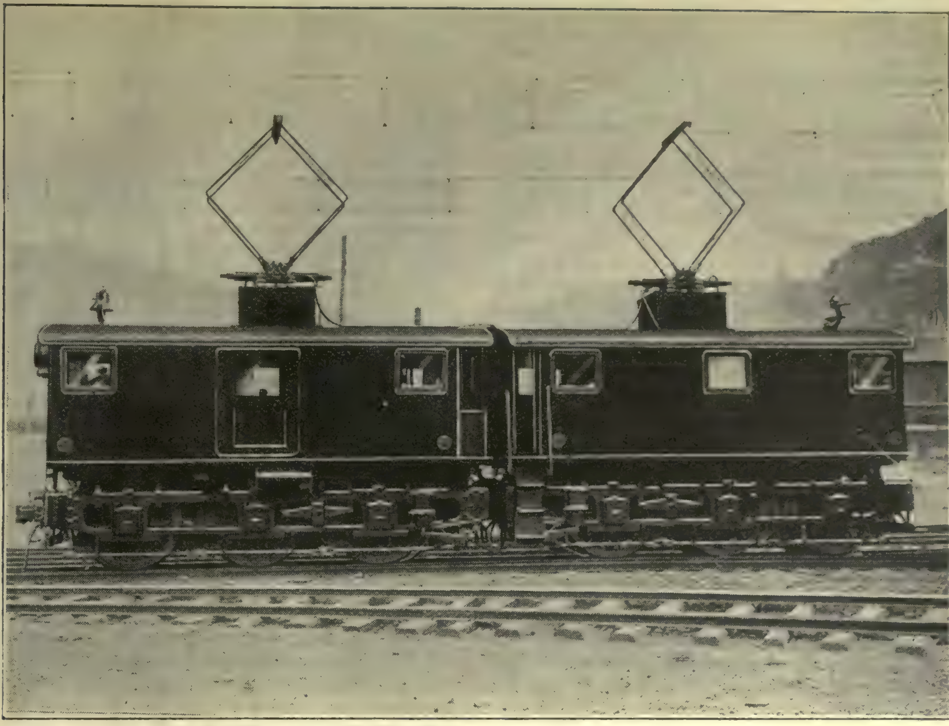
Mountain Railways. In places where the gradient is so steep that the adhesion of the wheels to the rails cannot be depended upon for hauling the train up the incline, or for controlling its speed when descending, it is necessary to adopt a positive means of driving and braking. This consists usually of a third rail in the form of a toothed rack, which is fixed to the track; a toothed wheel carried on the locomotive and driven either by steam or by an electric motor gears with the rack, and ensures a safe grip under all conditions. Naturally the speed on such a railway is slow—only from three to six miles an hour. Many such railways are to be met with in Switzerland and other mountainous countries, where they are often used solely to enable tourists to ascend famous mountains, such as the Rigi or Pilatus, without the trouble of climbing. The only examples of rack railways in this country are on the mountains of Snaefell in the Isle of Man, and Snowdon in Wales—the former electric, the latter steam-driven. An alternative method is to haul the trains up by a cable driven by a stationary engine, but this is practicable only over short distances.

Electric Railways. Turning to the electrical operation of railways in this country, this has hitherto been carried out on the "third-rail" system exclusively. In this system an additional rail is laid alongside the track, and by its means the electrical power is delivered to the train, returning either by the running rails or by a fourth rail laid for that purpose. The principal drawbacks to this system are humanitarian, as, even with the ordinary voltage (500 to 600 volts), an accidental contact with the third rail has frequently led to the death of the victim, and if a higher pressure were used, this untoward result would become almost inevitable. No Government would permit this risk, even if any railway company were prepared to run it; and, therefore, if the third rail is used at all, it must be at low pressure, which entails the handling of heavy currents. It is impossible to convey these large currents to any considerable distance without excessive losses or exorbitant cost, and the only alternative until recently was to transmit the power at high pressure to sub-stations, where it was converted to low pressure for distribution to the railway. As the conversion necessitated the use of running machinery, attendance was necessary in each sub-station, at considerable expense. The converting machinery also was costly, and liable to breakdown.

Electrification of Steam Railroads. The development of the single-phase alternating-current motor, however, during the last few years, has entirely changed the position. It is now possible to transmit the power to the trains through a single overhead wire at very high pressure, sometimes even without any transformation whatever; in this way the "live" conductor is removed altogether from the reach of human beings or animals, the cost of the electric equipment is reduced, costly sub-stations are done away with, line losses are enormously diminished, and various other advantages gained, with but few and unimportant drawbacks. Already several railways have been, and are being, equipped with this system on the Continent and in America, and one important company is about to adopt it for suburban service in London. Only by some such means is there any hope of eventually converting main lines of railway to electrical working.

High Speed Transit. The possibility of travelling at speeds much higher than those now in vogue has been much discussed of late years, and various projects have been put forward in which speeds of 100 miles per hour, or more, have been contemplated. On a Government railway between Berlin and Zossen, in Germany, specially strengthened for the purpose, experiments were carried out which culminated in the attainment of a speed of 130 miles an hour, thus proving the practicability of such a speed. Doubtless there would be no insuperable difficulty, from an engineering point of view, in constructing a high-speed railway between, say, London and Manchester; but the question is whether such a line could be made to pay dividends, and as this is the only basis upon which railways can be constructed, except when they are owned by the State, it is at present difficult to raise capital for the purpose. As a matter of fact, an Act has been obtained for the construction of a high-speed railway between Liverpool and Manchester, but, though several years have elapsed since then, it has not yet been carried into effect.

The Future of Land Transit. So far as can at present be seen, the use of automobiles is likely to increase indefinitely,



6. A WESTINGHOUSE 135-TON SINGLE-PHASE ELECTRIC LOCOMOTIVE
Showing the overhead conductors and sliding collectors

while the horse will be gradually superseded, to a large extent; electric tramways will be extended further into the country, on the overhead trolley system; progress will be made with the electrification of steam railways, first urban, then suburban and inter-urban, and finally main lines. With the steady decrease in the cost of electrical energy, due to improvements in apparatus and to the increased demand, the cost of traction will tend to decrease, but not very much. There is not likely to be in the near future any material increase in the speed of transit, except in cities, where it is at present abnormally low.

The next important step is likely to be the transmission of high-tension electric currents through the air, enabling the large sources of power, such as the Scandinavian water power and the falls in Central Africa and in South and North America, to be fully utilised. The loss in transmission should be but small. The principal difficulty at present is the production of a satisfactory motor. Later on the power available from the ether, referred to in the article on Power, may be utilised.

Water Transit. Although swimming is the most natural and primitive mode of progression by water, it has never been more than an occasional means of transit over short distances, even when artificial aids like Boyton's dress are used, apart, of course, from its great value as a physical exercise. Very early, man invented the raft, and soon followed the canoe, the coracle, and other primitive forms of rowing boat. The transition from the raft to the dug-out canoe was, in itself, no mean stride, and the further step to the boat built of planks constituted a remarkable engineering achievement. The modern rowing boat is a conveyance of the greatest utility, comparable indeed with the bicycle except in speed, and greatly superior in point of durability; but its scope is limited to smooth waters, such as those of rivers and inland lakes, for ordinary boats cannot safely venture far on the sea. A smart oarsman can scull at the rate of about eight miles an hour, but only under racing conditions.

Sailing Boats. Sailing boats are generally larger than rowing boats, and are able to keep the sea in fair weather. An enormous amount of goods transport is carried on by means of sailing barges on rivers and canals, at a low rate of speed, but at very small cost per ton-mile. Where the canals are frequently crossed by low bridges, as in this country, recourse must be had to towing, generally by men or horses, at a rate of about two miles an hour. On the Continent considerable progress has been made with the electrical towing of canal-boats, by means of tractors running along the towing path, and fed with electricity by overhead trolley wires; in this way a much higher speed is attained, from four to six miles, the actual speed depending largely upon the width of the

canal. In a narrow canal it is impossible to maintain a high rate of speed on account of the back current set up past the sides of the barge, which both retards the motion of the barge and damages the earthen banks. But little attempt seems to have been made to reduce this by better design.

Private sailing yachts are still used for long voyages, but have been largely superseded by steam yachts.

Sailing Ships. On a larger scale, the sailing boat becomes a ship, capable of voyaging to all parts of the world, and a large proportion of the world's trade is carried on to this day in vessels of this kind. The speed of sailing ships is much less than that of steamships, the former being dependent upon the strength and direction of the winds, and being unable, at the best, to sail much faster than a slow steamship. For many purposes, however, speed is of little moment compared with cost, and the latter is considerably less in the case of sailing ships, the capital outlay being less and, therefore, the charges much smaller. For the transport of grain, timber, etc., sailing ships are largely used; the total number of such, in fact, is nearly equal to that of steamships in the world, though the net tonnage of the latter is about twice that of the former. As regards safety, it cannot be denied that steamships have a great advantage, the larger vessels being able to defy bad weather with impunity.

Steamships. For passenger transit the steamship stands pre-eminent, and the finest vessels ever built are destined almost solely for this purpose; the huge liners which ply across the Atlantic resemble floating hotels, every possible provision being made for the comfort and entertainment of the passengers. Although the attainment of high speeds at sea necessitates the consumption of vast quantities of coal, the driving power varying approximately in proportion to the cube of the speed. Every effort has been put forward to reach higher and higher speeds, so that nowadays it is not uncommon for a speed of 20 or 22 knots to be maintained throughout a voyage of several thousand miles. A few steamships exist which have a gross tonnage exceeding 20,000 tons, and carry more than 2,000 passengers, in addition to the crew of 500 or 600 men. Such monsters, which are larger than the famous Great Eastern, are used only on the Atlantic service, smaller and slower vessels being employed on other routes.

The Marine Turbine. Until quite recently the reciprocating type of engine was invariably used for the propulsion of steamships; the development of the steam turbine, however, has inaugurated a revolution in this respect. The turbine is eminently adapted to the purpose, its motion being wholly rotational, like that of the propeller which it drives. The conversion of the reciprocating motion of the ordinary type of engine into rotary motion involves the introduction of vibrations which it is impossible to neutralise completely, and the resulting pulsations are felt throughout the ship, whereas in a ship equipped with turbine-driven propellers of good design it is difficult to realise that the engines are in motion at all. This fact is of great importance in the transport of passengers. Another feature of the turbine is its remarkable economy. Higher speeds can be obtained with a smaller expenditure of fuel, and the turbine requires less attendance than the reciprocating engine. Hence it comes about that the largest and fastest steamships ever built—the 30,000-ton leviathans of the Cunard line—are equipped with Parsons' steam turbines of 65,000-horse power, a fact which implies immense confidence in the capabilities of the turbine, seeing that it has only recently been employed for the propulsion of very large vessels. Obviously, the turbine is ideally adapted for such a service as that between Great Britain and the Continent, and has already been adopted for several of the Channel steamers.

The Power of the Future. It is sometimes suggested that, in the future, vessels will be electrically driven. This, however, is a prophecy which is by no means likely to be realised at an early date. At present the only successful type of electrically-propelled boat is the electric launch, which carries a battery of accumulators. These must be charged at frequent intervals, and, therefore, the launch can never travel far from a charging station, though, of course, such station may be on board ship. Hitherto electric launches have been used only on rivers and other inland waters.

The prospect of propelling vessels by means of gas-engines is much brighter, and already a number of launches have been fitted with suction gas-producers and gas-engines of several hundred horse-power. The system, so far as it relates to marine propulsion, is still in the early stages of development, but at no very distant period we shall probably see large vessels equipped with gas producers and gas-engines and making long voyages. Launches fitted with petrol-engines are becoming by no means rare, and there is an undoubted field for this type of conveyance. On the Volga a 1,000-ton barge has been equipped with Diesel oil-engines, driving dynamos which supply electric power to motors coupled to screw propellers. This combination is said to be very successful. There are many advantages in having the propeller driven by an electric motor coupled direct.

Costs of Water Transit. The cost of conveyance by water depends upon so many and various conditions that it is exceedingly difficult to arrive at reliable general estimates.

We have, however, made some investigations into the cost of travelling by steamboat for long and short distances, with the following results. Sea journeys may conveniently be divided into two classes—short journeys, such as those between this country and Ireland, or the western countries of the Continent; and long journeys, such as crossing the Atlantic, or travelling to India and Australia.

In the case of the former, allowing for first-class accommodation, the cost varies between 0·4d.

and 1·17d. per statute mile, averaging about ¾d. per mile per passenger, at speeds also varying over wide limits, 12 to 26 miles an hour. The longest journeys are the cheapest.

In the case of long ocean voyages, allowing for good accommodation, but not the best (for which fabulous prices may be paid), the cost varies from about 0·58d. to 0·92d., averaging again ¾d. per mile. This is exclusive of food and attendance in each case. The speed depends upon the route and the line of steamships, and varies from 15 to 27 miles per hour. Here, again, the longest journeys are the cheapest.

As regards the cost of transport of goods by sea, a complicated system of classification is employed, and the rates vary widely on different routes. Hence, it is impossible in the space at command to convey any useful idea of the cost of freight by water.

Air Transit. Hitherto we have considered only means of transit over the surface of land and sea. There remains to be discussed the possibility of transit through the substance of air and water without contact with other media—transit through the earth in this sense being obviously impossible. This class of means of locomotion differs very markedly from those previously dealt with. When travelling on the land surface, motion is derived from the reaction between the solid earth and the vehicle due to the exercise of force between these bodies, or from the force of the wind acting on sails (the latter mode being employed only in rare cases). When travelling on the sea, motion is again derived from reaction between the sea-water and the vessel, the sea acting partly after the fashion of a solid body by virtue of its inertia, or from the force of the wind, or from the motion of the water itself. In the remaining case the vehicle is wholly immersed in the medium which both supports it and provides the necessary reaction without which locomotion is impossible, and the problems to be solved are correspondingly changed.

Factors in the Air Transit Problem. In the case of transit through the air, four factors have to be considered: flotation, propulsion, direction, and balance. The first of these is almost invariably obtained by means of a balloon filled with a gas of less density than that of the atmosphere, such as hydrogen or coal-gas. Hot air has been employed for this purpose, but is never used nowadays. Flotation alone is easily secured, and equilibration is readily attained by simply suspending the whole of the weight to be carried in a car of small dimensions beneath a balloon of spherical shape. With this arrangement ascents can be made to a height of several miles with a considerable degree of safety; but the balloon, with its load, is entirely at the mercy of the air currents, and the aeronaut can do no more than select, to some extent, a particular current by varying the buoyancy of the balloon, and thus rising or falling. In practice it may be taken that the direction and speed of travel are beyond the control of the aeronaut. In spite of these limitations, remarkable voyages have been accomplished in balloons.

Accomplishments in Air Transit. The fastest journey recorded up to the year 1784 was performed in a balloon, a distance of 150 miles being covered at a speed occasionally exceeding 24 miles per hour. The English Channel was crossed in the following year, and a speed of nearly 80 miles an hour was attained in the same year, over a distance of 46 miles. In 1802, 60 miles was covered in 45 minutes, or at the rate of 80 miles an hour, and in 1804, a distance of 800 miles was traversed in 20 hours. Numerous other examples could be given; but the only important instance of the use of balloons as a means of transit is found in the siege of Paris, during which 64 balloons were sent out of the city; of these 57 succeeded in escaping and delivering their despatches. These balloons carried out 155 persons, nine tons of despatches, and 3,000,000 letters. Nevertheless, it was found impossible to enter the city from without by means of balloons.

Dirigible Balloons. For hundreds of years men have tried to find some means of travelling in the air, but it is only during recent years that the advance of knowledge, more especially in the manufacture of light motors, has rendered a solution practical. There are three main lines of experiments: (1) Balloons; (2) aeroplanes; and (3) what may be called "flapping machines."

The variations in balloons driven by power have been but slight, consisting chiefly in varying the motive power, the arrangement of the fans, and the shape of the balloon. The first practical flying machine was built by Henri Giffard in 1852. It was 140 ft. long and 40 ft. in diameter, driven by an engine and boiler developing about 3-horse power, and weighing 330 lb.

There have been many other attempts since to solve the problem with dirigible balloons, the most successful being that of Tissandier Brothers in 1881, and that of Majors Renard and Krebbs in 1884. The latter used a primary electric battery giving about 5-horse power, and weighing with the motor 1,140 lb.

Experiments with Dirigible Balloons. Far more work in this direction has been done abroad than in England. The only attempts that are worth mentioning in England have been one by Mr. A. Gaudron, in 1898, with a balloon 60 ft. long and a 3½-horse power petrol motor; one in 1901, when Mr. Stanley Spencer passed over London, and one in August, 1905, when Dr. Barton and Mr. F. L. Rawson went from the Alexandra Palace to Woodford. Dr. Barton had been experimenting for many years, and the special feature in his airship was the use of aeroplanes between the balloon and the motive power. This is almost the only real novelty that there has been for many years. Two motors were used, giving nominally 50-horse power each, the total weight of the two motors being just over 500 lb. complete with carburetter, flywheel, etc., showing the great advance that there has been of late years in the design of light

motors. Since this ascent still further advances have been made, and the weight has been reduced from 10 to about 6 lb. per brake horse-power.

The two most successful experimenters of late years have been M. Santos-Dumont, and M. Lebaudy. The former succeeded, in 1901, in circumnavigating the Eiffel Tower in Paris and winning the prize offered by M. Deutsch to the first to perform that feat. The experiments of M. Lebaudy have culminated in his airship being taken over by the French Government. It is a great pity that the English Government are not moving more in this direction.

Aeroplanes. With regard to the second system, that of aeroplanes, which, when driven by propellers, rise in air by the virtue of the pressure of the air on the under side of large plane surfaces something after the manner of a kite, up to the present there has been but little success. The two most successful experimenters with aeroplanes in the form of gliding machines have been Herr Lillientaal and Mr. Pilcher. Both lost their lives while experimenting, though in neither case were they using motive power. In the first the aeroplane was allowed to glide through the air, Herr Lillientaal starting at the top of a hill, and in the second case the machine was being pulled along by a horse. There is not much doubt, however, that the first real successful flying machine will make use of some form of aeroplane. Considerable success has been recently obtained by the Brothers Wright in America by this form of machine, and experiments have been made recently with a full-sized machine in England by Dr. Barton and Mr. F. L. Rawson, and also in France. There is no difficulty at the present time in rising from the ground and maintaining a considerable speed even against a moderate wind, the difficulties being in balancing and in coming safely to the ground at the end of the flight.

Flapping Machines. With regard to the third method, that of flapping machines, no success worth speaking of has been obtained, although Herr Kress has completed models which rise from the ground, and Dr. Hutchesson, of Cambridge, has also succeeded in rising.

Very good results have been obtained in some trials, which have been kept secret, where a speed of about 10 miles an hour and a lift of 200 lb. per horse-power were obtained, without the use of any balloon or aeroplane. The principal advantage, however, of this flying machine was that it could rise or fall in the air practically without forward movement, and augment or reduce the speed when once in the air, this making it very easy to start or come to the ground again.

There is not much doubt that we are on the eve of a great advance in airships, as all the main difficulties have now been solved, and it is only a question of working out the minor details.

Submarine Navigation. Turning now to submarine navigation, this is in essence a very similar problem to that of aeronautics, the vessel being wholly immersed in the medium which both sustains it and provides the reaction upon which its forward progress depends. The difficulties, however, are in this case much less than in aerial navigation, owing to the greater density of the water, which provides abundance of support for the vessel. The essential difference in this respect is that the submarine boat has to be forcibly immersed, while the passengers must be absolutely shielded from the supporting medium. The first practical submarine was built in 1776, but little progress was made until Nordenfelt took up the matter in 1885. His boats, however, were a failure when submerged, owing to their instability, though they travelled well enough at the surface. France followed with the Gymnote, in 1888, and achieved considerable success. The Gymnote was propelled by electricity at the rate of six knots when submerged, and displaced 30 tons. The Gustave Zédé was built in 1893, displacing 226 tons. This vessel was driven with electric motors of 720-horse power at a speed of 9 knots when submerged. Later designs were of the "submersible" type, which was propelled by steam on the surface, and by electricity when submerged, with a range of 25 miles at 8 knots, 72 miles at 5 knots. The displacement was 200 tons when submerged. British submarines are built on the American Holland model; the first, in 1901, displaced 120 tons when submerged, and was propelled by 160-horse power gasoline motors on the surface at 8 knots, by 70-horse power electric motors when submerged at 7 knots, for four hours at a time. The batteries could be recharged by means of the gasoline motor. Like most modern submarines, these were submerged by inclining the horizontal rudders while going ahead. The latest boat, of which particulars are not yet published, is considerably smaller than those hitherto built. It is entirely electrically driven and, so far, has been very successful.

The Future of the Submarine. In spite of the great progress that has been made during the last few years, the submarine boat remains a dangerous vessel in which to travel, and can be used only for purposes of warfare, in which pursuit risks must be faced. There is no prospect that in the near future submarine navigation will become a practical means of transit for general use. Although the effects of wind and waves are neutralised at a depth of a few fathoms, other dangers and difficulties of even greater magnitude are encountered, not the least of which is that of steering a true course in the impenetrable darkness which reigns beneath the surface, and the necessity of maintaining a respirable atmosphere in the vessel.

Continued

ALGEBRAIC DIVISION

Division of a Compound Expression by a Monomial. Division by a Compound Expression. Examples

continued from page 2151

By HERBERT J. ALLPORT, M.A

DIVISION OF A COMPOUND EXPRESSION BY A MONOMIAL

40. From the result of Art. **26** it follows, since division is the inverse of multiplication, that *to divide a compound expression by a monomial we take the sum of the quotients formed by dividing the separate terms of the compound expression by the monomial.*

Example **1**. Divide $6x^4 - 2x^3 + 4x^2$ by $-2x$.

Here, we divide (i.) $6x^4$ by $-2x$, (ii.) $-2x^3$ by $-2x$, and (iii.) $+4x^2$ by $-2x$.

Hence, the required result is

$$-3x^3 + x^2 - 2x \quad \underline{Ans.}$$

Example **2**. Divide $15x^4y^5 - 12x^3y^6 + 3x^2y^3$ by $3x^2y$.

The quotient $= 5x^2y^4 - 4xy^5 + y^2 \quad \underline{Ans.}$

DIVISION BY A COMPOUND EXPRESSION

41. The method will be best understood by considering an example. Suppose we have to divide

$$10x - 5x^2 - 8 + x^3 \text{ by } x - 2.$$

We must first arrange both dividend and divisor either according to descending or according to ascending powers of some letter contained in each. In our present example the only letter is x.

On thus rearranging the terms we obtain $x^3 - 5x^2 + 10x - 8$ to be divided by $x - 2$.

$$\begin{array}{l}
x-2)x^3 - 5x^2 + 10x - 8(x^2 - 3x + 4 \quad Ans.\\
\qquad\ \ x^3 - 2x^2\\
\qquad\quad\ \ \overline{-3x^2 + 10x - 8}\\
\qquad\quad\ \ -3x^2 + \ \ 6x\\
\qquad\qquad\qquad\ \ \overline{4x - 8}\\
\qquad\qquad\qquad\ \ 4x - 8
\end{array}$$

Now, it is clear that the term of the highest degree, x^3, of the dividend must be the product of the terms of the highest degree in the quotient and the divisor. Therefore, the term of highest degree of the quotient is found by dividing x^3 of the dividend by x of the divisor; that is, the first term of the quotient is x^2. Now multiply the *whole* divisor, $x - 2$, by this x^2, and subtract the product from the dividend. This gives us $-3x^2 + 10x - 8$ for the remainder.

Evidently this remainder must be equal to the product of the divisor and the terms of the quotient, which have still to be found. Hence, in the same way as before, we see that the second term of the quotient is found by dividing $-3x^2$ of this remainder by x of the divisor; that is, the second term of the quotient is $-3x$. Multiply the whole divisor, $x - 2$, by this $-3x$, and subtract the product from $-3x^2 + 10x - 8$. This gives $4x - 8$ for our second remainder. Then, exactly as before, we see that the third term of the quotient is obtained by dividing $4x$ of the second remainder by x of the divisor; that is, the third term of the quotient is 4. Multiply the whole divisor, $x - 2$, by 4, and subtract from $4x - 8$. There is now no remainder.

We have thus subtracted x^2 times the divisor, $-3x$ times the divisor, and 4 times the divisor; that is, in all, we have subtracted $x^2 - 3x + 4$ times the divisor and found that there is no remainder. It follows, therefore, that the dividend is equal to $x^2 - 3x + 4$ times the divisor. Thus $x^2 - 3x + 4$ is the required quotient.

42. We see, then, that the process is as follows:

1. Arrange the divisor and the dividend in ascending or in descending powers of some common letter.
2. Divide the first term of the dividend by the first term of the divisor, to obtain the first term of the quotient.
3. Multiply the *whole* divisor by the first term of the quotient and subtract the product from the dividend.
4. Treat the remainder as a new dividend, and repeat the process until the highest term of the remainder is of a lower degree than the highest term of the divisor.

We shall now work a few other examples.

Example **1**. Divide $4x^4 - 8x^3 - 19x^2 + 53x - 30$ by $x^2 - 3x + 2$.

$$\begin{array}{l}
x^2 - 3x + 2)4x^4 - \ \ 8x^3 - 19x^2 + 53x - 30(4x^2 + 4x - 15 \quad Ans.\\
\qquad\qquad\quad 4x^4 - 12x^3 + \ \ 8x^2\\
\qquad\qquad\qquad\quad \overline{4x^3 - 27x^2 + 53x}\\
\qquad\qquad\qquad\quad 4x^3 - 12x^2 + \ \ 8x\\
\qquad\qquad\qquad\qquad\ \ \overline{-15x^2 + 45x - 30}\\
\qquad\qquad\qquad\qquad\ \ -15x^2 + 45x - 30
\end{array}$$

Notice that it is not necessary to "bring down" *every* term of the dividend after each subtraction. In the above example, for instance, the -30 is not required till we reach the second remainder.

Some examples require greater care in arranging the terms for each subtraction.

Example **2**. Divide $a^3 + b^3 + c^3 - 3abc$ by $a + b + c$.

Arrange the dividend in powers of a. Treat b as next in importance to a.

$$\begin{array}{l}
a+b+c)a^3-3abc+b^3+c^3(\underline{a^2-ab-ac+b^2-bc+c^2\ \mathit{Ans.}} \\
\qquad \underline{a^3+a^2b+a^2c} \\
\qquad\quad -a^2b-a^2c-3abc \\
\qquad\quad \underline{-a^2b-ab^2-abc} \\
\qquad\qquad -a^2c+ab^2-2abc \\
\qquad\qquad \underline{-a^2c\qquad -abc-ac^2} \\
\qquad\qquad\qquad ab^2-abc+ac^2+b^3 \\
\qquad\qquad\qquad \underline{ab^2\qquad\qquad +b^3+b^2c} \\
\qquad\qquad\qquad\quad -abc+ac^2\quad -b^2c \\
\qquad\qquad\qquad\quad \underline{-abc\qquad\quad -b^2c-bc^2} \\
\qquad\qquad\qquad\qquad ac^2\qquad +bc^2+c^3 \\
\qquad\qquad\qquad\qquad \underline{ac^2\qquad +bc^2+c^3}
\end{array}$$

The above division shows us that
$a^3+b^3+c^3-3abc = (a+b+c)(a^2+b^2+c^2-bc-ca-ab)$.

This result is very important, and should be remembered.

Example 3. Divide $a^5+a^4b+a^3b^2-a^3+a^2+b^3$ by a^3-a+b.

$$\begin{array}{l}
a^3-a+b)a^5+a^4b+a^3b^2-a^3+a^2+b^3(a^2+ab+b^2 \\
\qquad \underline{a^5\qquad\qquad -a^3+a^2b} \\
\qquad\quad a^4b+a^3b^2\quad +a^2-a^2b+b^3 \\
\qquad\quad \underline{a^4b\qquad\qquad -a^2b\qquad +ab^2} \\
\qquad\qquad a^3b^2\quad +a^2\quad -ab^2+b^3 \\
\qquad\qquad \underline{a^3b^2\qquad\qquad -ab^2+b^3} \\
\qquad\qquad\qquad a^2.
\end{array}$$

Here the quotient is a^2+ab+b^2, and there is a remainder a^2.

EXAMPLES 6

Divide

1. $-33a^3b^2c$ by $3abc$.
2. $12xy^4z^3$ by $-2y^2z^2$.
3. $-105abc$ by $-5abc$.
4. $4x^7y^2z^8$ by $4x^5yz$.
5. $27x^5-36x^3+18x^2$ by $-9x$.
6. $4x^2yz+6xy^2z-8xyz^2$ by $2xyz$.
7. $\frac{3}{4}a^2-\frac{1}{2}ab+3ac$ by $-\frac{1}{4}a$.
8. x^2-3x-4 by $x-4$.
9. $6x^2-19x+10$ by $2x-5$.
10. $2a^2-a-4a^5+1-3a^3-a^4$ by $a+1+a^2$.
11. $1-x^8$ by $1-x^2$.
12. x^4-a^4 by $x+a$.
13. $a^3-b^3-c^3-3abc$ by $a-b-c$.
14. $x^2-y^2+xz-yz$ by $x+y+z$.
15. $(a-1)^3+b^3$ by $a+b-1$.

Answers to Algebra

EXAMPLES 5

1. $3x^4y-3x^3y^2+9x^2y^3$.
2. $-4x^4y+4xy^4-4xy$.
3. $-5a^3bcxy^3z+5a^2b^2cx^3yz-5a^2bc^2xyz^3+10ab^2c^2xy^2z^2-10abc^3x^2y^2z$.
4. x^3+y^3.
5. x^3-y^3.
6. $x^4-a^2x^2+2a^3x-a^4$.
7. $x^4-x^3-2x^2+5x-3$.
8. $x^5-a^2x^3+(2ab-c)x^2+(ac-b^2)x-bc$.
9. $x^6-x^5y-4x^4y^2+3x^3y^3+x^2y^4+2xy^5+2y^6$.
10. $a^3+b^3+c^3-3abc$.
11. $(1-x)(1+x)(1+x^2)$
$=(1-x^2)(1+x^2)$
$=1-x^4$.
12. $(x^2+y^2+xy)(x^2+y^2-xy)(x^4-x^2y^2+y^4)$
$=\{(x^2+y^2)^2-x^2y^2\}(x^4+y^4-x^2y^2)$
$=(x^4+y^4+x^2y^2)(x^4+y^4-x^2y^2)$
$=(x^4+y^4)^2-x^4y^4$
$=x^8+x^4y^4+y^8$.
13. $\{(b+c+a)(b+c-a)\}\{(a-\overline{b-c})(a+\overline{b-c})\}$
$=\{(b+c)^2-a^2\}\{a^2-(b-c)^2\}$. Art. **34**.
$=(b^2+c^2+2bc-a^2)(a^2-b^2-c^2+2bc)$. Art. **32**.
$=(2bc+\overline{b^2+c^2-a^2})(2bc-\overline{b^2+c^2-a^2})$. Art. **19**.
$=4b^2c^2-(b^2+c^2-a^2)^2$. Art. **34**.
$=2b^2c^2+2c^2a^2+2a^2b^2-a^4-b^4-c^4$. Art. **32**.
14. $(x-y)^2+(y-z)^2+(z-x)^2$
$=x^2+y^2-2xy+y^2+z^2-2yz+z^2+x^2-2zx$
$=2(x^2+y^2+z^2-yz-zx-xy)$.
15. $(x+2)(x+3)(x+4)(x+5)$
Since $2+5=3+4$, we multiply together the first and fourth factors and then the second and third, thus obtaining
$(x^2+7x+10)(x^2+7x+12)$
$=(x^2+7x)^2+22(x^2+7x)+120$
$=x^4+14x^3+49x^2+22x^2+154x+120$
$=x^4+14x^3+71x^2+154x+120$.
16. $x^2y^2p^2-x^2y^2q^2+p^2q^2x^2-p^2q^2y^2+p^2q^2y^2-p^2x^2y^2+q^2x^2y^2-p^2q^2x^2=0$.
17. $9x^2-81+2x^2-8x+8-4x^2-4x+80-6x^2+12x-6=x^2+1$.
18. $x^2+9y^2+16z^2-24yz+8zx-6xy$.
19. $9a^4-12a^3+34a^2-20a+25$.
20. $a^2+b^2+c^2+d^2+2ab-2ac-2ad-2bc-2bd+2cd$.
21. $(a+b)^2(a-b)^2=(a^2-b^2)^2=a^4-2a^2b^2+b^4$.
22. $27x^3-27x^2y+9xy^2-y^3$.
23. $1-12a+48a^2-64a^3$.
24. $(x+\overline{y+z})^3=x^3+3x^2(y+z)+3x(y+z)^2+(y+z)^3=x^3+3x^2y+3x^2z+3xy^2+6xyz+3xz^2+y^3+z^3+3y^2z+3yz^2$.
25. $(x-y-z)^3$ is obtained by changing the signs of y and z in the last example.

Thus,
$x^3-3x^2y-3x^2z+3xy^2+6xyz+3xz^2-y^3-z^3-3y^2z-3yz^2$.

NOTE. Examples **18**, Nos. **4** and **5** (page 1442) should read as follow:
$\sqrt[3]{456533}$ and $\sqrt[3]{18399744}$.

Continued

ARCHITECTURAL DESIGN

Vertical and Horizontal Lines. Symmetry and Balance. Curves. Mouldings and Ornamentation. Examples

continued from page 2135

By GASPARD TOURNIER

THE novice is constantly finding he is hampered in his conception for an elevation through imperative features on the plans which frustrate it, and he is tempted to sacrifice these for the sake of what he thinks will produce a finer effect. This he should never do, for no elevation which maims a good plan is ever a success. He should let the plan tell its own story boldly in the elevations. That way alone leads to legitimate originality. Fig. 22 is a fine design for a Technical School at Trowbridge, by Messrs. Wimperis & East. Ordinary orthodoxy called for the side wings to go up to the main cornice with some form of terminal emphasis, but there was no need for it in the plan, so the architects frankly omitted it, and the result is striking and happy. Among our foremost artistic architects who are loyal to plan and let their architecture grow from it is J. J. Stevenson. Fig. 25 shows an example of a house designed by him at Prince's Gate. He has been accused of being an extremist in rationalism—instanced in the exposure of naked gas pipes on the face of interior walls—but *all* his work is full of good essence which the student will do well to analyse carefully.

20. IMPERFECT BALANCE

21. A GOTHIC ARCADE

Vertical and Horizontal Lines. The relation of vertical to horizontal lines is an important matter to which beginners always fail to give enough attention. When a design needs to have its height emphasised, vertical lines should predominate over horizontal ones, and the reverse should occur when a low, broad result is wanted. But in the first instance, the horizontal lines should not be too often broken in their continuity.

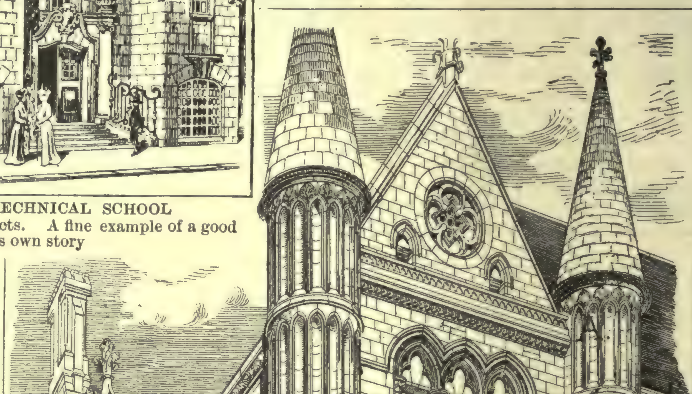
The London Law Courts [23] is an example of this. Breaks, such as A, B, and C, are overdone, and tend to disjoint the building into too many unasso-

22. DESIGN FOR A TECHNICAL SCHOOL
Messrs. Wimperis & East, Architects. A fine example of a good plan telling its own story

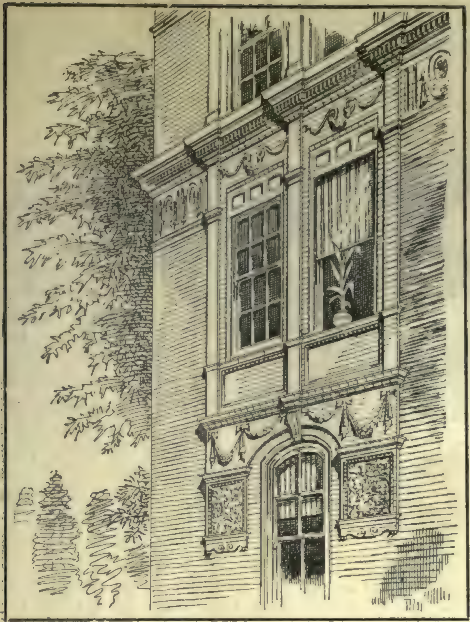
sloping or batteyed walls also help sympathetically towards the object attained.

Symmetry Versus Balance. Symmetry is a correspondence of parts on each side of a centre. Without due attention to this, a balance of parts is necessary, or the result will be lumpy and unhomogeneous. Fig. **20** is an example of bad balance. Fig. **27** shows the same theme better balanced. It is exceedingly difficult to define in words the matter here involved. Balance does not involve a set arrangement of parts, as of chessmen on a board, but a pleasing relationship between them. This happens when a kind of drift and counter drift of the lines have been played against each other, and in this way the members of the design compensate each other for their irregular shapes. A drift of line, curved or straight [28], running in one direction, suggests a want, at the end, of being met by a counter drift of lines across the path, leading in this way to the formation of ciated divisions. The entire stopping of the horizontal continuation of one storey, as at DD, is often permissible to give height to what adjoins; and so are breaks such as F [21]. It does not follow that even important horizontal members, such as deep cornices, should not be broken through when environment asks it, as in **24**, but moderation is called for in all these cases.

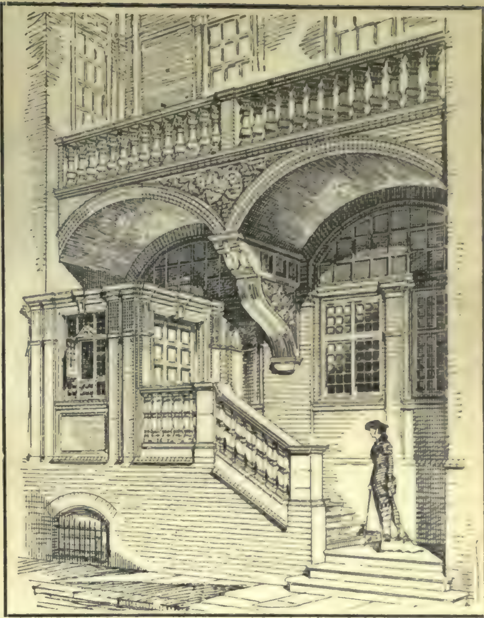
Harmonious Surroundings. A building should be in harmony with its surroundings. Often a good design fails to look well when erected by reason of its lines jarring with those of its environment. For instance, a village church in a valley, or on a plain with a background of hills, should not have an orthodox spire darting up. Fig. **26** is a good example of a church designed in harmony with the hills around it; and the slightly



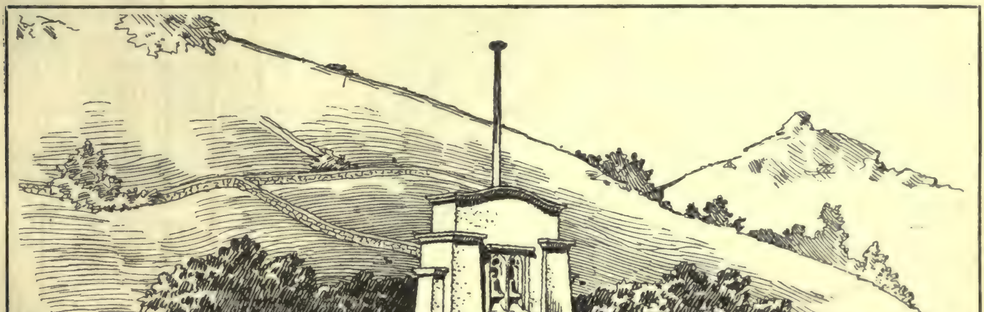
23. THE LAW COURTS, STRAND
Correlation between vertical and horizontal lines



24. HOUSE AT PRINCE'S GATE
An example where picturesque result justifies the breaking into main cornice by vertical members



25. HOUSE AT PRINCE'S GATE
An instance fulfilling the principle that plan should influence elevation

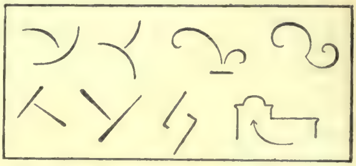


26. A VILLAGE CHURCH
E. B. Lamb, Architect. Well illustrating the principle that the lines of a building should always sympathise with the background of the site

masses in rhythmic balance. Many definitions have been given. We suggest this simile, by which we have often found a student derive an enlightening hint when other explanations have been misunderstood by him; but it is by personal practice in designing that he can best get at the right grasp of this matter.

27. BALANCE

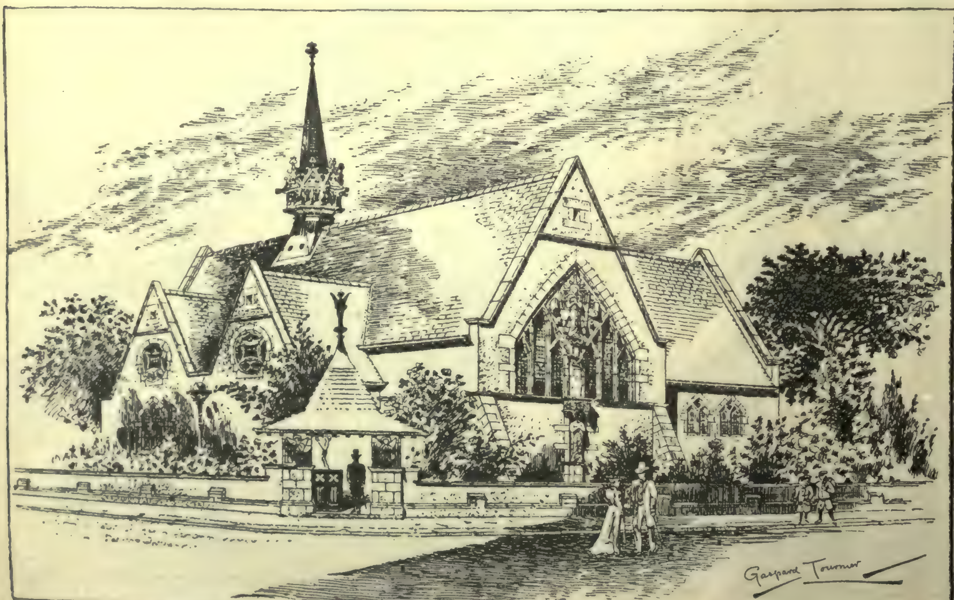
Beginners are apt to confuse quaintness and dignity in one design, but they should not be confounded. Fig. 29 is quaint, 8 [page 2129] is dignified. The one is simply a small church of inexpensive construction, the other a large building of noble proportions; but these attributes are not those involved. Quaintness in large buildings can be given impressive importance, as in many cases of Flemish town halls, etc., and dignity can be also present, perhaps, by the addition of a bank front of very narrow width. The two attributes to which we refer are incongruous, and should not be jumbled together.



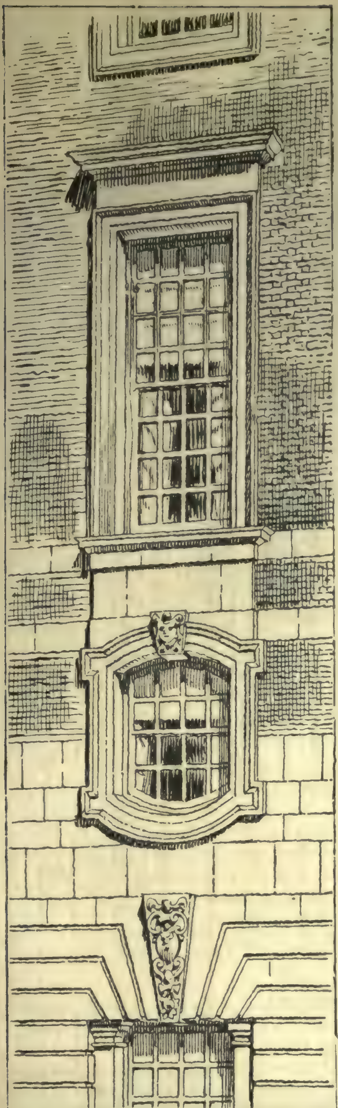
28. THE PRINCIPLE OF BALANCE AS DISTINGUISHED FROM SYMMETRY

The Supporting of Mass. The weight and visual bulk of an object must have below it that which satisfies the eye as being just adequate for its support, neither more nor less. This principle in large buildings is often violated. Study it first in minor items, such as in a pedestal, and that which is on it. Statues frequently fail in this, the base outraging the eye through its excess.

In Fig. 33, the right ratio is very nearly satisfied. Pedestals supporting standards for gas or electric light repeatedly show this want—standards starting with excessively massive bulk, attenuating to such an ethereally weightless thing as a flame or incandescent glow-spot. There should be more gradation of members from the pedestal to the light. The medium



29. "QUAINTNESS" AS DISTINGUISHED FROM "DIGNITY"



30. WINDOWS OF "COUNTRY LIFE" OFFICES, COVENT GARDEN

E. L. Lutyen, Architect. A fine example of justified "playfulness" in curved lines

need not necessarily be a figure, but metal or other branchings upward, conceived in a similar spirit. This principle is akin to, but not the same as, the feeling which has led the shafts of columns, in classic architecture, to be tapered upwards [see the Five Orders of Architecture], or the sloping of the design for the grave in **34**. This is called *entasis*. Some hold that the satisfaction it gives to the eye is due to an optical tendency for all vertical lines to appear to fall outwards. But, if this is so, the eye would long since have called for all vertical lines to all buildings to conform to the rule, and this has not happened. The feeling seems more to be the outcome of special cases where the subject designed requires its stability to be unusually emphasised.

Playfulness in Curves. A poet has said: "Curved is the line of beauty." There is a tendency in modern Classic Renaissance to take this very much to heart—more so than many critics approve of. But, when kept within bounds, as a contrast to straight lines, playfulness in curves charms exceedingly. The sill to the window in **30**, taken from Mr. E. L. Lutyen's masterly design for "Country Life" offices in Covent Garden, is very happy. The impulse has also led to an increase of curved lines by giving them to members horizontal in plane [**31**].

To avoid intemperance in curves, the student should analyse "Spanish Renaissance and the Flamboyant Period," where it is carried to excess. The beginner easily perceives the crime of such atrocities as a wallpaper designed to imitate grained oak, or a cement surface scratched with lines to represent

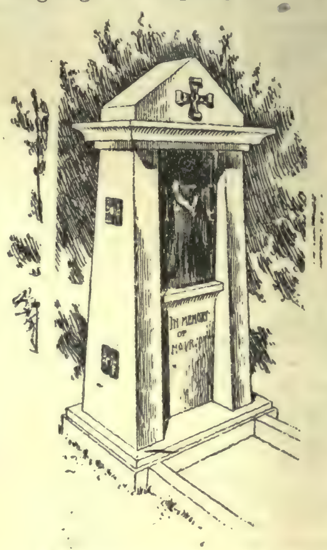
31. A BANK ELEVATION

By Gaspard Tournier. Showing the use of curved lines

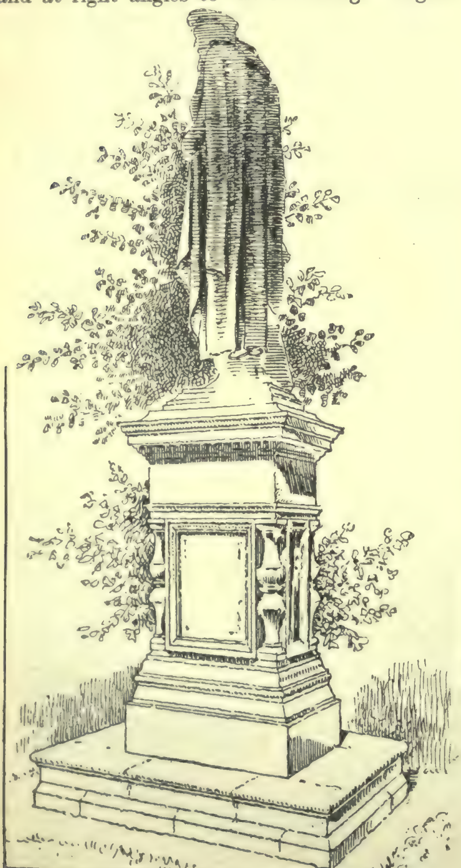
32. GOTHIC MOULDINGS
A style distinct from classic

the joints of stones; but, apart from actual shams, no materials should be called on to be manipulated in a way which, though physically quite possible, is not appropriate in their position. For good style, no feature should be forced into inappropriate positions or shapes.

The Functions of Mouldings. Students are apt to start with wrong ideas of the purpose of a moulding. They too exclusively consider how it looks when drawn on paper in cross section at a right angle to the moulding. On the ultimate building this section is never seen except on occasions when the moulding abuts direct against a flat surface at the end, and at right angles to the moulding. Regard must be given to how the moulding will look at the mitre when it turns at an angle. Then the section seen along the edge of the mitre has the same perpendicular proportions, but the horizontal proportions have widened out. The primary purpose of a moulding is to obtain shaded lines on the building of varied width and degrees of depth—some hard, some strong, got by angles more or less undercut in section, and some soft or blended, got by curves in section. Then, as regards the style or feeling put into the line of the section's profile, each historic style of architecture has its own type; but, for the practical purposes of modern designing, these group into two types—the Classic and the Gothic. Typical classic mouldings are seen in the Five Orders of Architecture, Gothic ones in 32. These two methods of getting shaded lines mix in the Elizabethan style of architecture, which was the basis of our English Renaissance. The fore-named purpose of mouldings is the first consideration; the right idea of their form comes with the growth of the student's artistic sense of fitness in all things.



34. DESIGN FOR A GRAVE



33. CAXTON MONUMENT, EMBANKMENT GARDENS, LONDON. E. W. Goodwin, Architect

Ornamentations. Ornamentation should afford a contrast to plain parts, and be something more than mere ornament.

Space for light to windows and egress to doors must not be sacrificed for artistic effects obtained unreasonably at the expense of these requisites, as is often the case.

The physiognomy of a building should tell its purpose. A church should look like a church, not like a theatre. The use for which a building is to be erected should be the keynote of the architectural melody it plays.

These are the main points where we have found students going wrong in architectural designing, through disregard or misconceptions of their meaning. In no case should the designer be satisfied with his work until it can stand the ordeal of being submitted to the fore-named considerations and satisfying them without any apparent effort or strain. He must not think any of them trifles which may be violated for the sake of what he may consider a brilliantly good point.

Architecture concluded

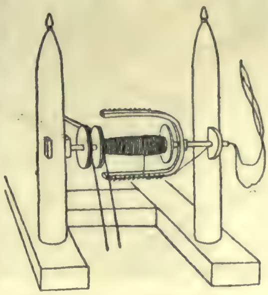
Continued from page 2100

FIRST PROCESSES IN SPINNING

Slubbing and Roving. The Bobbin and Flyer. Slubbing, Intermediate, and Roving Frames. Wool Spinning. Gilling Machines

By W. S. MURPHY

Bobbin and Flyer. Every textile worker should be acquainted with the principle of the bobbin and flyer [79]. At one point and another, in all branches of our industry, it comes into play. The original of this fine contrivance was part of the Saxony wheel, a picture of which has been given. Upon the head of the spinning-wheel, supported by two wooden pins, sits a horizontal spindle, holding a bobbin. On the head of the spindle a fork is fixed, the legs projecting parallel with bobbin and spindle. This fork is the flyer, hollow at the head, and the legs set with little hooks. From the big fly-wheel below, two bands come up, one passing round the wharf of the spindle, and one passing round the smaller wharf that controls the bobbin. It needs but a little knowledge of mechanics to enable one to understand that if two driving bands of the same speed are put round wharves of different sizes, the speed of the smaller must be greater than the speed of the larger. Conversely, the larger can travel an equal distance at a slower rate of speed. The spinner's thread is passed through the head of the flyer, in through one of the hooks on its leg, and round the bobbin. When the wheel is set agoing, the bobbin, by its greater speed, drags at the thread, while the flyer, whirling round, holds and draws out the thread, giving it a twist.

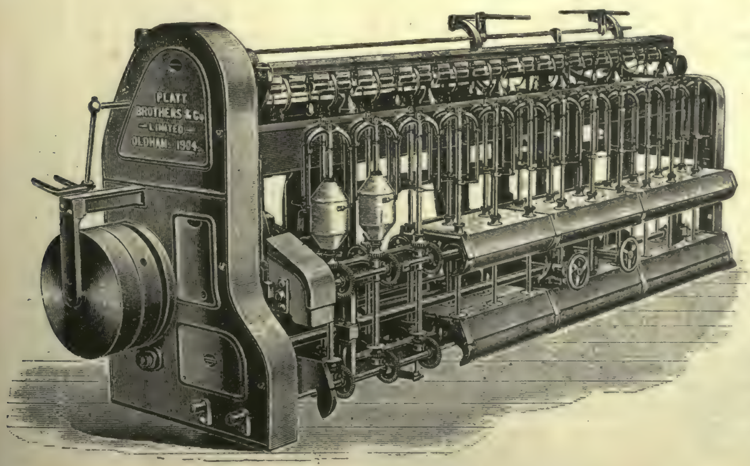


79. BOBBIN AND FLYER

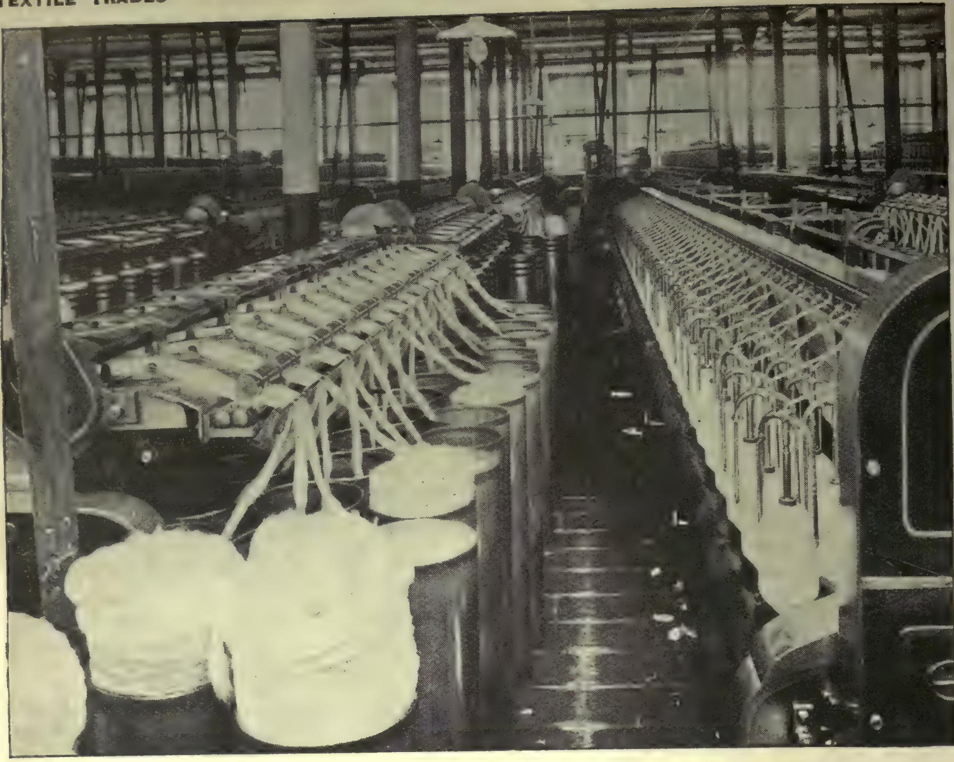
The rude contrivance of some unknown spinner has been largely developed in the hands of the great mechanics who have made the textile factory what it is; but the principle remains, and we shall see it on every variety of spinning frame.

Cotton. Cotton manufacture, as we have observed, is very definite. One operation follows another in rapid sequence. The slivers are taken from the drawing frames, and the cans are set behind the slubbers [81]. As a rule, the slivers are doubled here once again, two slivers being fed to each set of rollers on the slubbing frame. When the doubled sliver has passed through the drawing rollers, it passes through the tube of a flyer set on a spindle, is hooked in the hook of the flyer leg, and thence round a bobbin revolving underneath. The bobbin would seem to be actuated by the spindle, but it is not. A separate drive controls the movements of the bobbin. If bobbin and flyer were revolving at the same speed, no yarn could be wound. The drawing rollers are constantly giving off yarn. Therefore the difference in the speeds of the bobbin and the flyer must be regulated according to the length of the yarn given off by the rollers. You may arrange to make the flyer lead, or give the lead to the bobbin, but the difference in speed must be had and maintained. The yarn is taken on the bobbin [82], but if it and the flyer remain in unchanged positions, the yarn will be wound all on one part of the bobbin. For this, provision has been made in the lifter plate, shown in 80, which carries the bobbin up and down with regular automatic movement.

Another difficulty occurs. The bobbin at the start is a thin tube; but as the thick rope winds upon it its circumference grows. If the same speed of drive is kept on, the surface travel of the bobbin must increase, and the ratio between it and the flyer alter. Many contrivances have been devised to quicken or slacken the speed of the



80. SLUBBING FRAME



81. DRAWING AND SLUBBING FRAMES (Horrockses, Crewdson, & Co., Ltd., Preston)

bobbin on a regular ratio ; but there are now two in common use.

Bobbin Drive. The cone drive is made up of pairs of cones, driving and driven cone opposing each other in reverse. A belt connects the two, and the bobbin takes its speed from the driven cone. As the belt travels in regular gradation from the one side to the other, the speed of the bobbins is graded to the thickness of the yarn wound. The other device is on a different principle, and has the merit of giving unity to the movements of the whole frame. We saw the lifter plate move up and down ; in this differential mechanism the lifter plate, at both the top and bottom ends of its traverse, releases a catch, which lets the regulating cone or bowl change its position. This bowl is fixed on the end of the rod which drives the bobbins ; it is actuated by two discs running in opposite directions ; the nearer the centre of the discs, the smaller its area of revolution, and therefore the slower ; the further out the bowl is between the discs, the more rapid its revolution, and therefore the stronger and swifter the drive. One can easily see that by setting the catch for the lifter plate it is possible to accelerate or lessen the revolutions of the bobbins.

Intermediate Frame. By the frame we have examined, the slubbings have been drawn and twisted, and wound on to bobbins ; now we take them to the frame called the intermediate [85]. Excepting that a creel of bobbins sits on the frame instead of the cans behind, and that the bobbins on which the yarn is wound are smaller, this frame differs in no way from the slubbing frame. Our illustration is taken from the latest and most improved pattern, made with Short's or Mason's collar, cone-strap tightening apparatus, Curtis and Rhodes' patent winding motion, locking apparatus to the knocking-off motion, suspended pedestal to the end of the pulley shaft, a brake to the fly-wheel, a disengaging motion to the bobbin shaft and lifter shaft, single and double cone, and other added patents. From the bobbin [83] the effect of the intermediate frame on the yarn can be plainly seen.

Roving Frame. The roving frame is the next machine. It is finer, and altogether a higher mechanism than any of the frames preceding, though the principle of its working is the same. As many as 160 spindles sit on one roving frame ; the bobbins are short and small, and the thread is fine [84]. When we aim at yarns above 200 counts, a second roving frame should be called into action. We should now have an idea of the exact count of our yarn. Of course, the underlying hypothesis of all our work has been that we knew from the beginning ; but sometimes fact contradicts theory. At any rate, we now begin to give the threads a definite name, and speak of a 20-hank, 30-hank, or 40-hank roving, by this meaning that so many hanks of 840 yd. each will go into

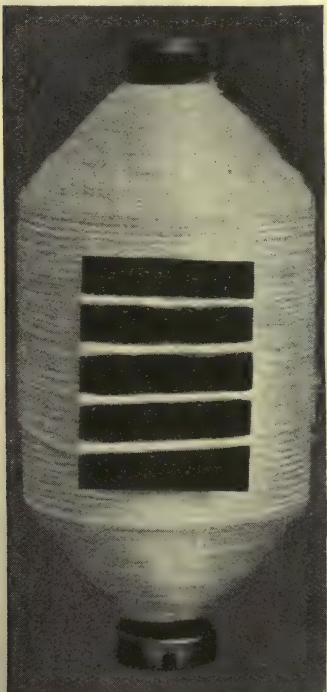
1 lb. weight. A 40-hank roving is very fine, and is generally spun into the highest counts.

Wool. When studying worsted drawing we stopped at the end of what is called the *first drawing-frame* because on the second the bobbin and flyer is used. There are other reasons. In no textile process is the practice more diverse. For long wools some manufacturers use six drawing-frames, two with faller gills and four with drawing rollers; others carrying through four drawings with the gills and two with the rollers. Again, for the shorter worsted wools there are yet two other methods at least, and upon these many variations are worked. Taking what is called the English method, we have nine drawing operations, which we shall detail hereafter. The second is the French method, coming gradually into use with us, and involving totally different machinery.

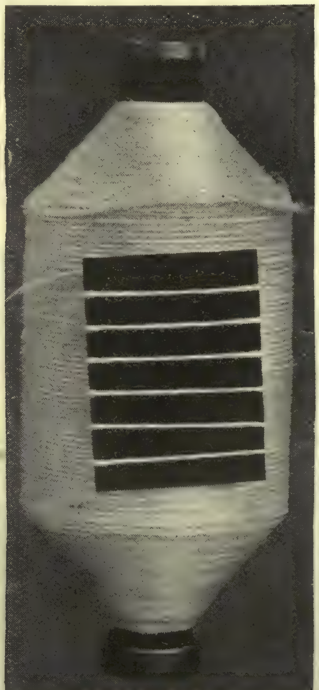
Gilling Frame. Returning now to the English method of drawing long wools, we note the special characteristics of the *second*, or *spindle* gill-box. Here the slivers are carried on combs, but there must be no draft on the sliver from the combs, the whole draft being in the rollers. From the delivery rollers the slivers, or *slubbings*, as they should now be called, are wound on to bobbins by the method before described. Adopting the most recent practice, we shall now discard the combs, and use only drawing rollers, the bottom rollers of each pair finely fluted, and the top rollers leather covered. By differentiated speeds the drawing rollers on what is named the four-spindle box elongate the fibres, and deliver to the bobbins a finer thread, which gets another little twist from the flyers. Refining still further, we pass the slubbings through the six-spindle weighing-box, the three six-spindle boxes, and the *dandy* roving-boxes. In the condition they leave the last, the slubbings, or rovings, are ready for the spinning frames.

Finest Worsted Drawing. Fine Botany wools, and wools of the best class, demand a treatment more prolonged. The system usually comprehends nine operations, which, as the mode of working should now be fairly clear, we shall merely enumerate. We operate (1) with two double-can gill-boxes; (2) with two two-spindled gill-boxes; (3) with four-spindle drawing-boxes, with bobbins 14 in. high by 8 in. in diameter; (4) with a six-spindle weigh-box, with bobbins same as last; (5) with an eight-spindle drawing-box, with bobbins about 7 in. in diameter; (6) with two eight-spindle drawing-boxes, bobbins 12 in. by 6 in.; (7) with two 24-spindle finisher-boxes, bobbins 9 in. by 4½ in.; (8) with reducers, with bobbins 6 in. by 3½ in.; and (9) with 30-spindle roving frames, with bobbins 5 in. by 3 in.

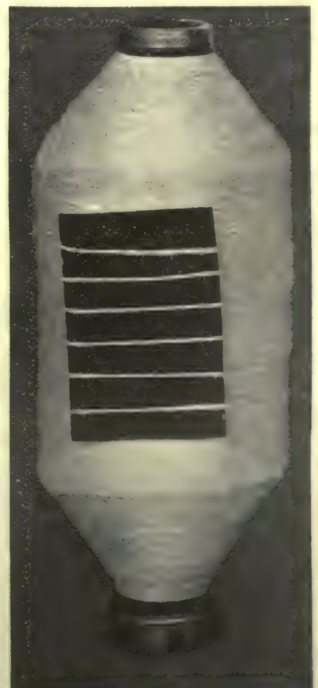
Both the first gilling machine [86] and the second gilling machine [87] are common to all methods of worsted drawing. The student will see from the illustrations the gradual advance in refinement and complexity.



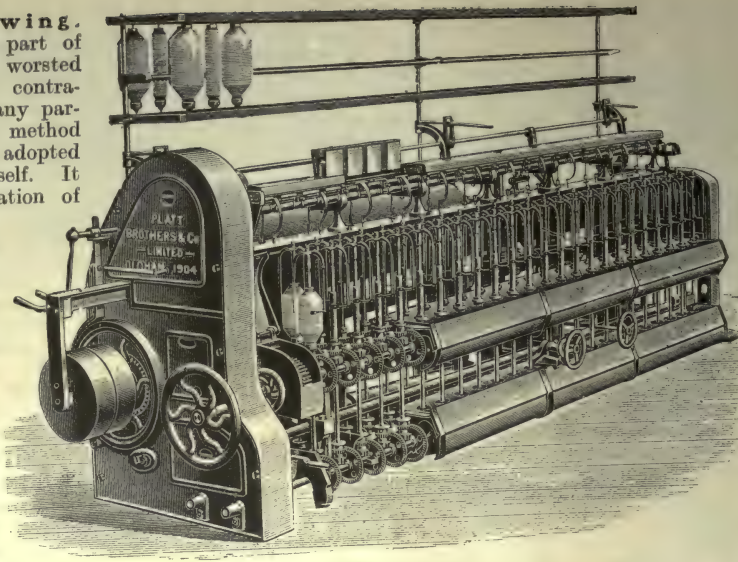
82. COTTON YARN AFTER SLUBBING



83. COTTON YARN FROM INTERMEDIATE FRAME



84. COTTON AS IT APPEARS AFTER ROVING



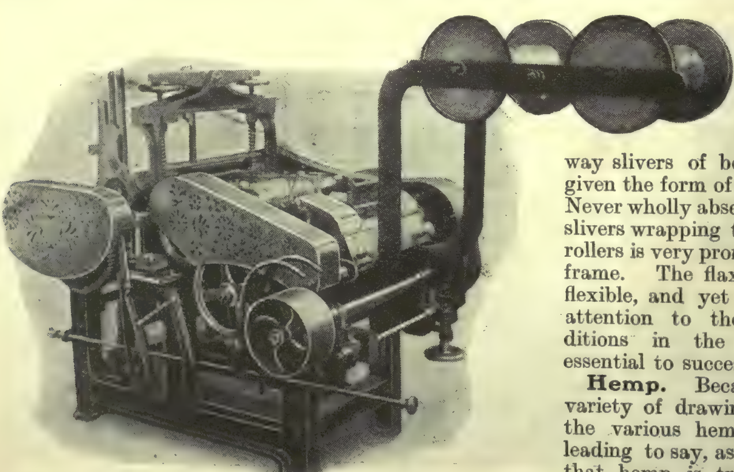
85. INTERMEDIATE FRAME

French Drawing. Though an integral part of the French system of worsted manufacture, which contradicts our own in many particulars, the French method of drawing has been adopted by some firms for itself. It is a curious combination of the waste-silk filling-engine, the drawing frame, and the condensers, and possesses features of some value [88]. The balls of sliver are brought from the gill-boxes, and hung two by two on the frame. The doubled slivers are passed into the back rollers, thence over a porcupine roller covered with little steel spikes set so as to lift the wool a little above the point of delivery of the back rollers. By this means the slivers are combed and drawn while being carried forward to the drawing rollers.

Having been thus drawn, the slivers now come in between a pair of rubber leathers. The rubber leathers are curiously constituted, being two pairs of rollers, an endless band of leather stretched round each pair, just like a feed lattice. The lower roller of the upper pair and the upper roller of the bottom pair, revolving in the same direction with an oscillating horizontal motion, make the leathers act as rubbers on the slivers passing between them. Rubbed into the semblance of a thread, and with a certain amount of added strength, the slivers are wound on to horizontal bobbins, which move to and fro, taking on the wool in spiral rounds, and building up an even spool.

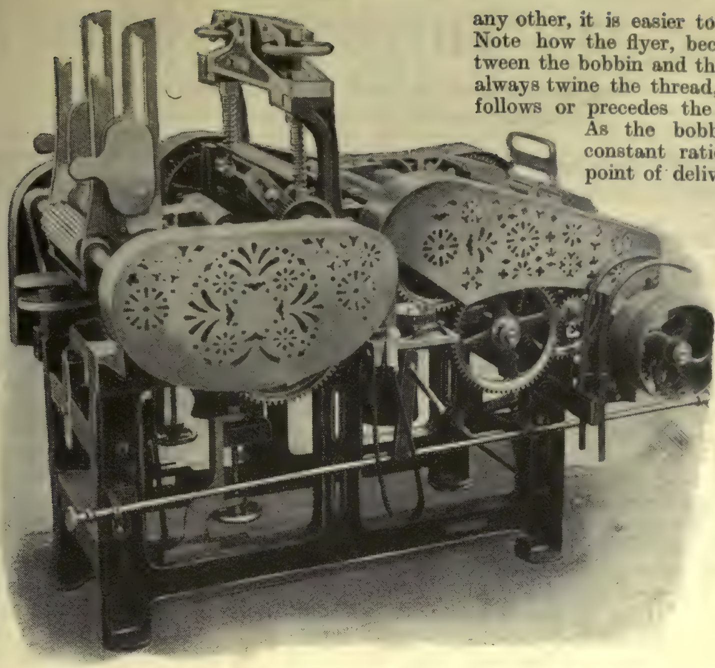
By repeated operations on machines of similar model, the sliver is at last formed into a fine thread, and prepared for the spinner.

Flax. The four drawings to which the flax sliver is usually subjected in linen manufacture have reduced it to fineness, cleanness, and uniformity. We must now get a twist on the weak rope, and have it put on bobbins. The roving frame differs only from the last drawing frame of the linen factory in one particular. Instead of the sliver delivery, we have the bobbin and flyer arrangement at the end of the frame. As we form the rove by one operation, there is no doubling at this frame. The sliver is fed singly into the rollers, drawn out and carried forward by the gill combs, and sent out by the delivery rollers to the flyers, which twist and wind it on the bobbins. In this way slivers of both line and tow are given the form of yarn we call *rovings*. Never wholly absent, the danger of the slivers wrapping themselves round the rollers is very pronounced at the roving frame. The flax must be kept soft, flexible, and yet not damp. Careful attention to the atmospheric conditions in the preparing-room is essential to success.



86. FIRST GILLING MACHINE (Taylor, Wordsworth, & Co., Leeds)

Hemp. Because there is a wide variety of drawing machines used for the various hemps, it would be misleading to say, as has often been done, that hemp is treated in exactly the same way as flax. Some machines which are employed on the drawing



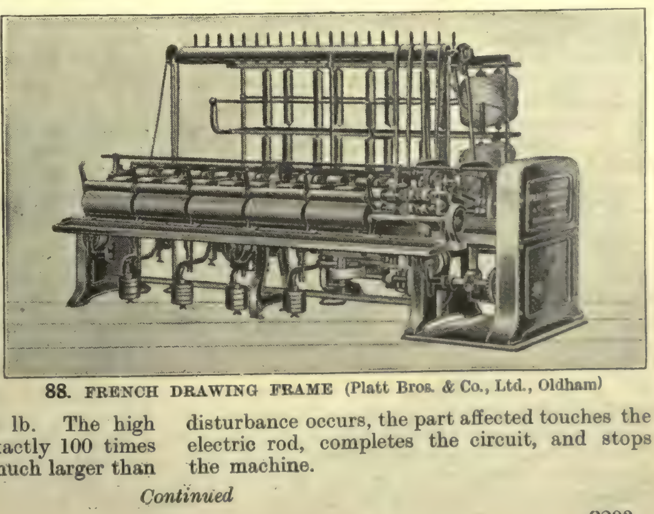
87. SECOND GILLING MACHINE (Taylor, Wordsworth, & Co., Leeds)

any other, it is easier to watch its operations. Note how the flyer, because it interposes between the bobbin and the drawing rollers, must always twine the thread, no matter whether it follows or precedes the bobbin in revolution. As the bobbin grows in size the constant ratios of speed keep the point of delivery always equal.

Electric Stop-Motion. No drawing frame of any class is without a stop-motion of some sort. In its earliest form, the stop only operated on the feed side, but later invention brought the delivery rollers also under its regulation. Each machine maker has his own patent, but the idea is the common property of the textile industry. The principle admits of general application, and by a variety of instruments. A fork, spoon, tumbler, or bar is adjusted to the sliver feed or yarn delivered, so that in case of break, attenuation, or other defect occurring in yarn or sliver, a lever, spring, or clutch acts upon the driving pulley, and throws it out of gear. An Accrington man conceived the idea of making the stop-motion merely the medium of the electric current which would stop the frame, and the idea has been successfully applied to frames of all kinds. From a small battery at the side of the frame, the current is carried to the rods which form, with the stop-motion parts, the electric circuit. When any disturbance occurs, the part affected touches the electric rod, completes the circuit, and stops the machine.

of manilla and sisal hemp are never seen in a linen factory. The fact may be put in this way. Whatever drawing frame has been used for preparing the sliver may be employed for the roving, with the addition of the bobbin and flyer. For coarse twines and the yarns of low quality ropes a long double drawing frame, with a bobbin and flyer at the end, is frequently employed. The higher qualities of common hemp are drawn and formed into rovings with the same elaboration as flax, and generally on the same machines.

Jute. We saw that the jute drawing frame had four gill-combs on each bar—on each bar of the roving frame we have eight—it is therefore easy to appreciate the difference in the fineness of the gill teeth. The rest of the machine is in equal proportion. The slivers have been drawn on the second drawing frame to a fineness of, say, 45 yards to the lb.; they are fed singly into the roving frame, eight slivers to each carriage, and drawn through to the flyers, which twist and wind them on to bobbins. If the roving frame has a draft of 7 to 1, the roving will be refined to a thread giving over 300 yards to the lb. The high counts of cotton rovings are exactly 100 times finer. As the jute frame is so much larger than



88. FRENCH DRAWING FRAME (Platt Bros. & Co., Ltd., Oldham)

Continued

THE NEW THEORY OF MATTER

The Electricity of the Atom. An Imaginary Atom. Experimental Atoms. Chemical Union Explained

By Dr. C. W. SALEEBY

THE root question of chemistry is the nature of matter, and we have already seen that while matter has the habit of existing in the form of atoms, these are elementary only in the sense of the older chemistry. Plainly, we must proceed to dissect them. Now, atoms are not mere aggregates or heaps or accumulations of simpler components—one atom, let us say, consisting of half a dozen, and another of ten. An atom, like a man or a society, is not an *aggregate*, but an *integrate*—that is to say, is not a *heap*, but an *organism*. A heap of stones is an aggregate, the cathedral which may be composed of such a heap of stones is an integrate, and it is not without reference to this analogy that we have had occasion to liken an atom to St. Paul's.

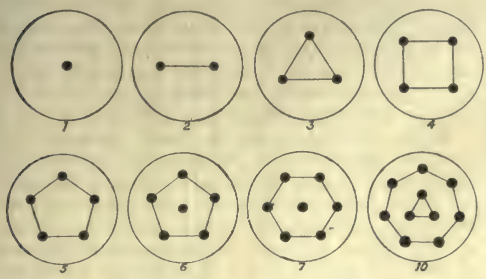
The Anatomy of the Atom. In discussing, then, the anatomy of the atom (the reader will observe the interesting contradiction in terms—the cutting up of the uncuttable)—in discussing the anatomy of the atom, we have two distinct problems. The first is to ascertain the nature of the units which compose it, their different kinds if they be of different kinds, and their characters; the second is to ascertain their relations to one another—with this noteworthy complication, that these relations are not permanent and changeless, such as the relations of the stones in a building, but are constantly undergoing rearrangement, which strongly suggests the evolution of thoughts and feelings in the mind of man, or the evolution and molecular change that is to be found in a living cell.

On account of reasons which will probably make themselves evident, we may begin with the second problem, towards which we are more directly led by our previous study of the older chemistry. For the moment we shall ignore its more difficult part—the question of the changes of relation that constitute the evolution of an atom. Admitting that such changes occur, we may ignore them and confine ourselves at present to a study of the relations between the parts of an atom as they are believed to persist for long periods—perhaps thousands or millions of years in the case of the lighter and more stable atoms. It would obviously be premature at this stage of our exposition to tackle directly such a complicated question as that of the birth of the helium atom from the atom of radium. But the reader is already aware that we have identified bodies which we may call electrons or corpuscles, and of which atoms are composed, in part, at any rate. In the case of radium, we knew them at first as the *Beta* rays, and their distinctive characteristic is that they carry a charge of negative electricity.

The Electricity of the Atom. For the present we need no more facts save to remember that if these negatively charged corpuscles are to live together so as to constitute an atom, there must be some bond of union between them. "Like electricities repel"; one negative corpuscle will not be reconciled with another unless there be "positive electricity," so-called, which will master them both. We may thus assume, according to the teaching of several students, the first of whom in our time was Lord Kelvin, whilst the chief worker is Professor J. J. Thomson, that an atom is an area where there is positive electricity of such an amount as will balance—as will exactly balance, if the atom be stable—the sum of the negative electricity of all its constituent corpuscles added together. We might assume that the atom was a flat object, that all its electrons lay in the same plane; but it is more satisfactory, and doubtless much more nearly true, to assume that the atom is spherical, and has, in short, a tri-dimensional character. For the present we will make this assumption; but the reader must on no account allow himself to be persuaded that atoms are asserted to be really spherical. The sphere, however, is the simplest figure that we can choose if we are to abandon any attempt to represent the atom as a flat object, and the sphere is, beyond a doubt, much nearer the truth.

An Imaginary Atom. Now, Professor J. J. Thomson's inquiry is this: Assuming that the atom is a sphere of positive electrification, in which lie a number of negatively electrified bodies, how would they tend to arrange themselves, and what would be the consequences of their arrangement? In order to simplify our problem we must assume—and never forget that we have only assumed it, not proved it—that the electrons, or negatively electrified corpuscles, are at rest. We have, of course, every ground to believe that they are by no means at rest, but we must attack the simpler question first. Again, it is believed that in the case of the simplest known atom—that of hydrogen—the number of electrons, or negatively electrified corpuscles, must be from 700 to 1,000; but, plainly, we cannot begin with such figures, and must consider what would happen in the simplest conceivable cases. The simplest of all is that, of course, in which there is only one negative electron, and that exactly balances the positive electrification of the atom. In such a case, the negative electron would lie at the centre of the sphere. If there were two corpuscles, they would be balanced with themselves, and with the positive electricity—that is to say, the atom could exist as a stable object, assuming that no outside

force interfered with it—on condition that they were placed upon a diameter of the sphere at points exactly midway between the centre and the circumference. If there were three corpuscles, they would have an equally simple arrangement, forming an equilateral triangle, symmetrically arranged about the centre of the sphere. If there were four corpuscles, they would form a square; five would form a pentagon. And at this point we begin to reach a marked difference. We might expect that, if the number of corpuscles were increased, they would behave just as they do when the number



ELECTRONS IN THE ATOM

is so few—that is to say, they would arrange themselves in a continuous figure just as if they lay on the surface of a smaller sphere placed within the sphere that constituted the boundary of the atom; but, indeed, they would not, and cannot.

Not so Simple as it Looks. Such an arrangement would appear satisfactory, since it might be supposed that the whole structure would be balanced by the positive electricity and the negative electricity, thus having what looks like a symmetrical arrangement. Supposing this were so, the difference between a heavy and a light atom would depend simply upon the number of the corpuscles that constituted it, and the difference in the relations between the corpuscles would simply amount to this: that in the lighter atom they were less crowded than in the heavier. There might thus be a perfectly regular arrangement; there might just as well be an atom containing 937 corpuscles as one containing 938. One would not be more stable than the other, and the properties of the two would differ in the infinitesimal degree which the difference in their structure would require.

But if we look at the list of the elements arranged, let as say, in order of atomic weight, we find no such simple sequences. There is not a uniform measure of increase in weight as we ascend the list, nor is there a uniform change in the properties of the elements represented. The pre-eminent feature of such a table, as we have again and again insisted, is that it is *periodic*. Groups of characters come and go, and come again. There is a more or less regular recurrence of them. That is the whole meaning of the term "periodic law."

The Survival of Atoms. Now, Professor Thomson has shown that directly the number of corpuscles increases beyond five in the model atom we have imagined, a new kind of arrangement is met, and the result of his mathematical inquiries, together with certain experimental facts, and together with the known facts of the periodic law, leads us to the conclusion that systems such as we have imagined are stable only under certain conditions. For instance, if there were 938 conpuscles in such a sphere, it might be stable; but if by chance it lost one, the 937 could not arrange themselves in any stable fashion. It might be necessary for 21, or any other number of additional corpuscles to be lost before a stable structure could be possible. Is it not more than probable that the gap between, let us say, uranium and radium, or lead and silver, is capable of some such explanation as this? And here, again, we may discern a new meaning in the assertion which we made in a previous chapter as to the possibility that Empedocles was right, and that the law of natural selection, or the survival of the fittest, is true of atoms as well as of living things.

Brief Life of the Atom. We remarked that the reason why there is so very little radium in the world is that its atom is unstable; it can survive for only a brief time, so that many specimens of it cannot accumulate. It was further asserted that we must now regard the 75 or 80 different kinds of atoms with which we are acquainted as the relatively stable survivors from an infinite number of conceivable atoms, most, or indeed all, of which may have momentarily come into existence again and again, but have been unable to survive. It is believed that the number of electrons in an atom of mercury is about 200,000, and those in an atom of radium about 250,000 (perhaps more nearly 225,000). Why, then, should there not be at least 225,000 or 250,000 elements, if it be not that the laws of atomic structure permit only 75 or 80 to survive?

Professor Thomson has shown that instead of one ring or sphere of corpuscles, two are necessary directly we go beyond the number of five [see illustration]. Of these, one consists of fewer corpuscles than the other and is nearer the centre; throw in a few more, so to speak, and three groups are required, later four, and so on. It has been said that we conceive of the atom as having three dimensions, but it is possible to make most interesting experiments of the highest illustrative importance and having strict accordance with Professor Thomson's calculations from purely abstract considerations, if we are content for the moment to conceive of the atom as two-dimensional or flat.

Experimental "Atoms." The experiment was devised by Professor Mayer. First, a surface of still water represents the plane of the flat atom. Each negative corpuscle is represented by a little magnetised needle which is made to float by being thrust through a piece of cork. The needles are all arranged so that

the negative poles are uppermost and the positive poles below. The negative poles behave to one another as the corpuscles of an atom must behave to one another, tending to repel one another with a force varying according to the law which is now so familiar to us—the law of inverse squares. Now, some arrangement has to be provided to represent the positive electricity which holds the atom together, and this is easily done by a positive magnetic pole which is hung over the water.

Supposing we start with one needle; it is immediately fixed under the magnet. Throw in another. The first moves from its original position, and the two assume the positions we have already defined; and so on through the triangle, the square, and the pentagon until, when a sixth needle is thrown in, we find not a hexagon but a pentagon with one needle in the middle of it. Later on, two go to the middle, then three, forming a triangle; then there is a square, a pentagon, *and so on and so on* [see illustration]. We must closely recognise the significance of this. Here is the periodicity which the other arrangement—now proved to be impossible—did not display, the periodicity which the periodic law demands. For observe what happens, supposing we strip off the outer ring and leave an inner triangle [see 10 in illustration]. Plainly, we have an atom such as one we have already seen. Plainly also, the fact of the triangle will tend to make the larger atom resemble, in some degree at any rate, the smaller. Perhaps the one stands for chlorine and the other for bromine. And another fact needs almost equal emphasis. It is the sudden transformations of the entire grouping which may be caused by the insertion of one needle more; while if yet another be added there may be little modification. It just takes its place in the outer ring. That is true, for instance, if the numbers be 16, 17, and 18, but if one more needle be thrown in, the whole structure is changed and, as it happens, the change is still more marked when the twentieth is thrown in. Supposing we multiply all these figures by a few hundreds we can now readily understand how it is that numbers of corpuscles intermediate between the figures so obtained could not form a stable atom at all. They might make a momentary attempt to form an atomic organism amongst themselves, but it would immediately collapse.

Movement of Electrons. The complication introduced by the fact that the electrons must certainly be conceived as in motion is not so serious as would appear. We can imagine these various rings in a state of rotation around the centre of the sphere, without the grouping of the corpuscles being altered. The complexity introduced by the fact that Mayer's needles are in a plane, while the corpuscles of the atom must have a tri-dimensional arrangement, is much more serious, but it is by no means insuperable. Already, Professor Thomson has succeeded in his initial attack upon it and, so far as the plane arrangement is concerned, or the arrangement in rings rather than shells, he has shown how such corpuscles must be arranged up to numbers well on the way to a hundred.

Application of the Theory. Let us now see what facts this new theory of the structure of matter enables us to understand, premising most clearly that we are by no means attacking the ultimate question yet, but have merely advanced our problem from the stage in which the properties of the atom seemed to be entirely mysterious to a further stage in which they seem to be more or less intelligible—both stages being no further than atomic, however We are very far indeed yet from considering the further question which must face us afterwards. But taking the subject at this stage, let us see which of the properties of matter we can explain, confining ourselves for the purposes of the present course to those properties which may be called more distinctly *chemical*.

In the first place let us take valency, the curious property of atoms in virtue of which they seem to have a varying number of arms, while the newly discovered group of inert atmospheric gases have no arms at all. When we come to study the behaviour of Mayer's needles or of the negative electrons which we have conceived, according as 13 14, 20, etc., of them are organised within one area of positive electrification, we find an intelligible explanation for, at any rate, the main facts of valency, and are not without prospect of explaining all the rest.

We find that when there are, let us say, 60 corpuscles in the organism of the atom —the reader, of course, understands that the figure is quoted merely "for purposes of illustration"—the addition of one more corpuscle does not fundamentally alter the structure of the atom. In another case it is similarly found that the subtraction of one corpuscle does not fundamentally alter the structure of the atom; or the atom may tolerate the loss or gain of two corpuscles or three, but no more.

Atoms such as the first we have supposed will be one-handed, the others will be two-handed, three-handed, and so on respectively. Thus, we may reasonably suppose valency in any case to be determined by the number of electrons which the atom in question can gain or lose without having its whole constitution altered—without, for instance, having to arrange its electrons into three groups instead of two, or five instead of six.

The No-handed Elements. The reader may ask what chemical differences correspond to the difference we have suggested by using the alternative "gain or lose," and we shall now see that the alternative corresponds quite satisfactorily to observed facts. But let us spare a word for the no-handed elements. Now it is the most remarkable fact that this zero group of elements fits as satisfactorily into Thomson's theory as we have already seen it to fit into the periodic law of Mendeleef. On the supposition already stated, the peculiarity of the particular numbers of electrons that compose the atoms of the members of this group should

be that they cannot tolerate the loss or the gain of *even one electron* without losing their stability. Such a structure plainly will be without any combining power at all. Now, it is found that the arrangement of 59 electrons and also that of 67 is in this case, and it is surely very much more than a coincidence that seven atoms are possible between these two, and that seven atoms do in fact occur—lithium, beryllium, boron, carbon, nitrogen, oxygen, fluorine—between helium and neon, as also indeed between neon and argon. Thus, the theory provides a satisfactory explanation for valency and for absence of valency alike.

The Explanation of Chemical Union. This magnificent theory will also lead us to understand the fundamental facts of chemical union. Plainly, it would not be of very profound value if it failed to explain the most characteristic and abundant of all the facts of chemistry. For long years men have spoken of chemical forces and chemical affinity and chemical energy. The philosophic mind has always expected that some day these powers would be resolved and recognised as essentially one with the other manifestations of energy in the universe. The physicists long ago outstripped the chemists in a similar respect. They showed the identity of heat and energy of motion [see PHYSICS]. They showed the correspondence between heat and work, heat and electricity, and so on; and they framed, some half century ago, the great generalisation of the conservation, the convertibility, and the ultimate identity of all the forms of energy. Sooner or later the chemists had to fall into line with this doctrine—as, indeed, they did not hesitate to admit.

The Electrical Nature of Chemical Forces. Of recent years, evidence for the ultimately electrical nature of chemical forces has accumulated, and Professor Thomson now seems to have solved the problem altogether. The chemical elements are divided or classified according to their electrical properties, some being more or less markedly electro-positive, while others are more or less markedly electro-negative. If we look at a list of the elements we find that, let us say, No. 1 is what is called electro-positive, and so on increasingly till No. 8, which is still more so, whereas No. 9 is very electro-negative, and so on. There is not a continuously steady rise and fall in this electrical property, but sudden interruptions, and then continuous rise or fall for a time. Thomson's theory of atomic architecture completely explains this fact.

An atom with a certain number of electrons has, let us say, 15 in the outer ring and 10 in the inner. Now, according to mathematical theory, 10 is the smallest number for the inner ring that is compatible with the presence of 15 in the outer ring. Such an atom has, so to speak, no rope to spare. It is electrically unstable or electro-positive; add another electron, and it becomes very unstable or electro-positive; and then, at a certain point a totally new arrangement is reached, and the atom becomes very stable or electro-negative again. Well, let us suppose that sodium and chlorine atoms are placed in one another's company. The sodium atoms are electro-positive, and are readily capable of losing one electron apiece, being therefore also one-handed. The stability of the chlorine atoms, again, is compatible with the acquirement of one electron apiece. They are thus electro-negative and also one-handed. Obviously, the circumstances are fit for combination between these atoms and the compound sodium chloride will result, owing to an electrical attraction between the positive atom of the metal and the negative atom of the halogen. The electron which the one atom loses is conveniently accommodated in the other atom.

Explanations of Periodic Law. We have already insisted upon the importance of the fact that the arrangement of Mayer's needles —as experimentally observed, and as demonstrated about a year ago at the Royal Institution by Professor Thomson before the most illustrious audience which the present writer has ever seen there—that this arrangement has a definite law of periodic recurrence as the number of needles is increased. Purely abstract mathematical considerations have also demonstrated the necessity for this periodicity. At last we see why, on reading the table of the periodic law, we come at recurring intervals to elements that resemble one another. Whereas we find that No. 1 and No. 2 are dissimilar, No. 1 resembles Nos. 9, 16, and 23, let us say; while No. 2 resembles Nos. 11, 18, and 25. Thus we have groups such as lithium, sodium, and potassium; phosphorus, arsenic, and antimony; the group of the halogens, and so forth. While these resemble one another chemically when subjected to the ordinary tests, the physician can add the corroborative evidence that their actions on the human body display similar resemblances. The theory of Thomson fits in to a nicety with all these facts.

What One Electron May Do. Our imaginary atom with 20 electrons may have them arranged in an outer circle of 12, an inner of seven, and one central one, which has got as near as it can to the positive magnet as illustrated in Mayer's experiment. If another needle or electron be inserted, the whole arrangement may be completely altered. You get an atom of a totally different kind; which is to say that you get an element having totally different properties, as different, let us say, as the properties of sodium and magnesium—which follows it in the table of the periodic law. But when a certain number more be added, what we find is a reproduction of the original arrangement with the addition of an outer circle, representing the new electrons added. Plainly, the first arrangement suggests such an atom as sodium, the last arrangement such an atom as that of potassium, and the theory explains the similarity between the two; while the intermediate arrangement or arrangements represent the atoms of magnesium, aluminium, silicon, phosphorus, sulphur, chlorine; the unlikeness between sodium and potassium on the one hand, and all these other elements on the other hand, similarly made intelligible.

Value of the Theory. Indeed, this great theory co-ordinates and illuminates whole series of facts hitherto awaiting explanation. It is justly comparable to discoveries like those of gravitation, natural selection, the association of ideas, or the circulation of the blood. The discovery of the periodic law constituted an epoch in chemistry. It consisted in the observation, grouping, and correlation of a very large number of individual facts. It is really worth while to point out the remarkable correspondence between the work of Mendeleef in this respect and the great labours of Kepler. The astronomer spent years in observing the planets and finally deduced from them his three laws of planetary motion. They constituted an epoch in astronomy, but obviously neither the periodic law nor Kepler's laws constitute the final stage of the inquiry. In each case we must ask a further question: What is the explanation of the laws already ascertained? Why do the planets move in this fashion? Why do the elements display this periodicity? The Kepler and the Mendeleef are alike essential, but their work is completed and their labours crowned when a Newton arises to elucidate the greater law of gravitation, of which the laws of planetary motion are merely consequences, and a Thomson arises to elucidate the fundamental fact of atomic architecture, of which the periodic law is similarly only a consequence. Indeed, we are able to say that if matter be really made of electrons the atoms of the elements are inevitably bound to display that periodicity of properties which Mendeleef demonstrated but could not explain, just as Kepler demonstrated but could not explain the movements of the planets.

Further Proof. Every kind of confirmation that can possibly be suggested is being found to come to the service of what its author calls the corpuscular theory of matter. We have already mentioned facts of valency and of absence of any valency; the facts of chemical union; the facts of the periodic law; the facts of the grouping of the elements. To these we may add the facts of the triads of elements which were mentioned in a previous chapter. It was pointed out that in the case of chlorine, bromine, and iodine, for instance, or calcium, strontium, and barium, the atomic weight of the middle element stands almost exactly midway between the atomic weight of the first and third elements. It is an easy matter to study the groupings of small numbers of corpuscles as, for instance, 61, 41, and 25, and show that if these numbers be taken to represent atoms, the atomic weight of the middle atom is about half-way between the atomic weight of the first and third atoms. The three atoms closely resemble one another. The fact is explained when we look at the groupings. Twenty-five corpuscles form three rings, containing 13, 9 and 3; these three rings are found to recur when we take 41 corpuscles; there is merely a fourth ring of 16 added outside them. Again, they recur when we take 61 corpuscles, having this time not merely the fourth ring of 16, but a fifth ring of 20.

A completely different method of inquiry affords yet new confirmation to Thomson's theory. It is found that when the light emitted by any element in a glowing state is analysed by means of the spectroscope, constituting the process called Spectrum Analysis [see PHYSICS], definite and distinctive characters can be recognised as belonging to each element, such characters ultimately depending, of course, as we now see, on the structure of their atoms. Now if we take the spectra of a group of elements we find that they are related to one another in structure, and Professor Thomson has shown, by mathematical reasoning, that groups of electrons related to one another in the fashion indicated in the previous paragraph would necessarily produce related spectra of the kind actually observed.

Groups and Series. Reference has already been made to the fact, which we may well emphasise, that the electrical characters of the elements afford further confirmation of the theory. When elements are arranged in groups, as in the table of the periodic law, we may read the columns downwards, in which case, for instance, we get such a sequence as helium, neon, argon, krypton, xenon; or may read across, in which case we get such a sequence as that recently quoted, consisting of the seven elements that lie between helium and neon—*viz.*, lithium, beryllium, boron, carbon, nitrogen, oxygen, fluorine, these elements belonging respectively to groups one to seven. Such a sequence as this last constitutes what, in order to emphasise it, we call a *series* of elements as distinguished from a group. Now, a group consists of members which closely resemble one another, but we must recognise that there is also a relationship, though of a quite different kind, between the members of a series. This relationship is most clearly expressed in the case of the electrical properties of the elements already referred to, and corresponds in the most amazing way with the relationship which ought to exist if Thomson's theory be correct.

The Last Stage. Now we must ask the reader to recall certain statements which we made in introducing this part of our subject. The whole significance of Thomson's theory has not yet been stated. We have yet to apply it to the existence of unstable atoms and to see whether it explains their behaviour as well as it does that of the stable atoms with which we are now familiar. Furthermore, as has already been insisted, we have by no means pushed to the last stage our inquiry in what we call the root question of chemistry. It is all very well to speak of a sphere of positive electrification, for instance, but whence does it come? Of what, or in what does it consist? Similarly, with the negative electrons. When we discussed radium we spoke of the shooting out of some of these from the atom of radium. But if these things are the ultimate constituents of matter we must follow them and see what becomes of them.

Continued

THE BRAIN AND SPINAL CORD

Five Divisions of the Brain. Centres of Spirit, Soul, and Body. Development of the Brain. Formation of Habits. Reflex Actions

Continued from page 2147

By Dr. A. T. SCHOFIELD

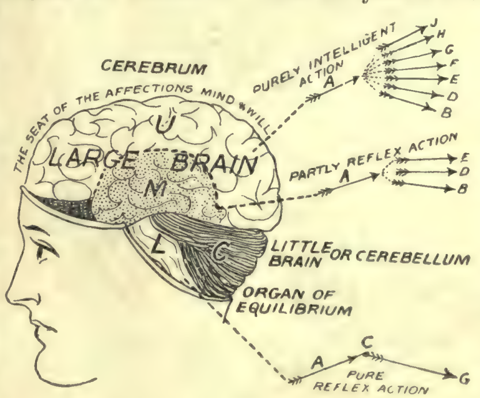
We have examined generally the structure and leading divisions of the central nervous system, and found that it may, like the liver, be conveniently connected with the number *five.* There are five divisions. In the cerebrum [122] we have the upper brain or hemispheres, the mid-brain, and the lower brain, or medulla ; also the cerebellum and spinal cord—five in all.

Each hemisphere has five lobes, and the brain has five ventricles, while connected with it directly are the five senses.

The next point is, as we have seen, that it consists generally of two parts—the grey matter which forms the outside of the brain and the inside of the cord, and the white matter which forms the inside of the brain and the outside of the cord. The grey consists of nerve cells forming the vital battery that energises the nerves, or wires, and discharges "vital" force. The white consists of nerves, which are the wires along which the impulses travel.

We will now consider the respective functions of the different parts, and will begin with the cortex and hemispheres.

The Seat of the Conscious Mind. The surface of the hemispheres, or cortex, is believed to be in a special way the seat of the conscious mind or spirit of man. The convolutions represent the extent of his faculties ; the more numerous and deeper they are, the more extended are these. It is probably here, too, that memory lays up her stores of knowledge. As actions arising from cortical excitement are voluntary and intelligent, and the direct result of the conscious mind, nowhere do we find greater evidence of the value of education than in this region. It is mainly composed of brain cells, though, of course, the nerve fibres are quite innumerable. These cells differ somewhat in appearance according to age. The diagram [123] roughly distinguishes their appearance in infancy, manhood, and old age. It will be seen that whereas the cells are *in infancy* blunt and only slightly pointed, and in many cases round, *in manhood,* after education and development are completed, they become sharp, with long processes, to which innumerable fibres are attached ; *in old age,* again, a good many of these processes appear to be worn off.



122. PARTS OF THE BRAIN
U. Upper brain *M.* Middle brain *L.* Lower brain, or Medulla *C.* Cerebellum

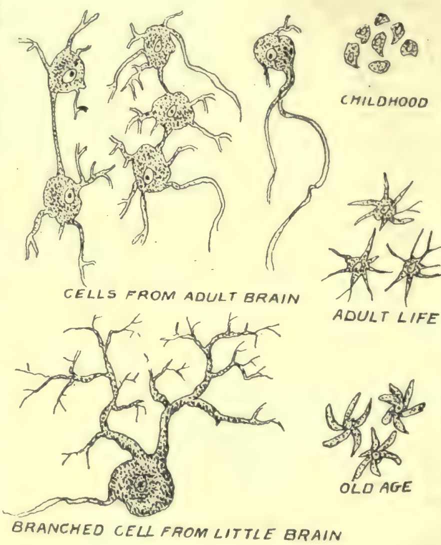
Effect of Education. The difference education makes in the brain is like that between an untrodden forest, such as that through which Stanley passed in Africa, and a civilised country. In the former we get a pathless, trackless wood, through which progress in any direction is made with the utmost difficulty ; in the latter, good roads, leading easily in any direction we wish.

The business of education is to construct these pathways or connecting threads of knowledge in the brain. This is still more strikingly seen as we proceed to the other brain divisions, but is of great interest here.

How Knowledge is Acquired. When a child begins to read, certain brain cells receive from the eyes the letters H O T ; but it is a long while before connections are established with the various motor cells that enable the child at once to say "Hot" whenever it sees these letters, and by certain connection with these higher centres to form the idea of burning and heat at the same time. A person bereft of these convolutions in the upper part of the brain might be able to read "Hot," but could not understand what he read. The more a child's higher faculties of thought and reason and memory are exercised, therefore, the more (within reasonable bounds) pathways of knowledge are formed through this brain forest, and the easier does learning become ; and thus in after-life the man's brain power is enormously increased by a varied and liberal education.

What Occurs on Removal of Upper Brain. The following painless experiment, showing that the cortex of the brain is the seat of intelligence, is well described by Professor Huxley : "If a frog be narcotised, and its convolutions removed (being the upper division, but the middle and lower divisions left), the animal sits on the table, resting on its front limbs in the position natural to a frog, and breathes quite naturally ; when pricked behind it jumps away, often getting over quite a considerable distance; when thrown into water, it begins at once to swim, and continues swimming until it finds some

object on which it can rest; and when placed on its back, immediately turns over and resumes its natural position. Not only so, but the following very striking experiment has been performed with it: Placed on a small board, it remains perfectly motionless so long as the board is horizontal; if, however, the board be gradually tilted up so as to raise the animal's head, directly the board becomes inclined at such an angle as to throw the frog's centre of gravity too much back, the creature begins slowly to creep up the board, and if the board continues to be inclined will at last reach the edge, upon which, when the board becomes vertical, he will seat himself with apparent great content. Nevertheless, though his movements, when they do occur, are extremely well combined, and apparently identical with those of a frog possessing the whole of his brain, he never moves spontaneously, and never stirs unless irritated. If, however, only the upper part of the spinal cord be left, these movements cannot be performed."



123. VARIETIES OF BRAIN CELLS

Seat of the Animal Life. If the cortex, or upper brain, be considered as the seat of the *intellectual* life, or *spirit*, of man [**124**], the mid-brain is the chief seat of the *animal* life of man, or what is often spoken of as the *soul* ("The moving creature that hath soul"—Gen. i. 20, Marg.), while we shall be able to show that the lower brain, or medulla, is the seat of the *physical* life, or the functions essential to the *body* life. If the lower brain, or medulla, acts alone we have just passive physical life-breathing and the beating of the heart, etc., going on, but no movements—*i.e.*, the *body alive*, or mere *existence*. If the mid-brain acts as well, we have, in addition, movements of all sorts of the most active description, but without intelligence—that is, the full manifestation of animal life, or the *soul and body alive*, or *movement*. If, in addition, we have the highest part, we have intelligence, or reason, directing or guiding the whole, together with the power of consciousness and abstract thought, and the *spirit, soul, and body* alive.

Illustration of Functions of the Three Brains. Now to illustrate this. Take the case of a person reading a book aloud and understanding it. He comprehends, and probably reads it by the action of his intellectual life, or *spirit;* he holds it in his hand by the action of his animal life or *soul;* and he gets the breath to read it with from the action of his passive physical life, or *body*.

If the highest centres be paralysed, he ceases to read, but still holds the book and breathes. If the middle part then be paralysed he drops the book, but still breathes. If the lowest part then be paralysed, he dies.

Effect of Alcohol. The three divisions are also well illustrated in the phenomena of drunkenness, for alcohol paralyses the brain *in this very order*.

First the intellectual or rational life goes and the animal life is left without reason to guide it, so that the man jumps about, laughs, and sings, without any reason to guide him. If he takes more of the poison, the mid-brain is paralysed, and he becomes "dead" drunk. He falls down, and no longer uses his animal life, or moves any limb, but he still breathes. If someone now pours more down his throat, the lowest part, or medulla, is paralysed, and he dies.

We get in this mid-brain the centres of sight, hearing, taste, sense, and speech—at any rate on their mechanical side. The two pairs of large bodies—the corpora striata and the optic thalami—situated here are believed to be the centres respectively of mere motion and sensation of any part of the body; the centres for intelligent action or feeling being of course in the cortex. The mechanism of the movements of this part will be considered a little further on.

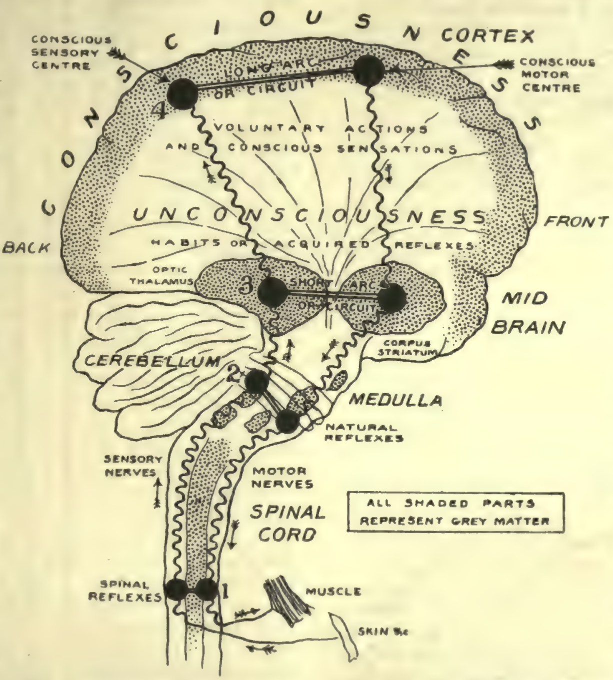
The Brain that Works Unconsciously. The lower brain, or medulla oblongata, is the centre of the passive or inner life of the body. We will recall a few of its features. It is the upper expanded part of the spinal cord within the brain, just beneath the cerebellum, or little brain. It is an inch and a half long, three-quarters of an inch broad, and half an inch thick. It is much broader above than below, and at the upper part it is crossed in front and beneath by a broad band of fibres known as the *pons varolii*; the cerebellum, or little brain, over it forms the roof, while the medulla forms the floor of the fourth of the five ventricles, or chambers of the brain. In its surface are embedded, one on each side, two rounded bodies the size and shape of olives. They are called the *olivary bodies* [pages 2144-6].

The medulla is, of course, largely composed of white nerve fibres passing up to the brain, but it is also the controlling centre for the most important and vital actions of the body. Here is the centre that controls *respiration*, that controls the *swallowing of food*, the power of mastication or chewing, the *formation of saliva;* every one of these so far, it will be seen, is connected with the supply of food to the body. It is also the centre for *regulating the action of*

the heart, and the *size of the blood vessels*, especially of the skin. Under fear or cold it contracts them, and we become pale; under shame or heat it expands them, and we blush. It also contains centres for *regulating the size of the pupil of the eye*, for *taste*, and for *hearing*, and for some of the mechanism of *speech*. The medulla, together with the cord, is the centre of what is known as pure reflex action.

Why We Yawn. Nerve currents from the lungs and other parts are sent to the medulla when the blood contains too much carbonic acid; the blood itself circulating in the medulla also irritates the respiratory centre so that a reflex action occurs and force is transmitted to all the muscles concerned, causing a deep inspiration to purify the lung. This automatic—or more properly reflex—action may easily be proved by experiment. It is called reflex because it is, as it were, reflected back again, like a ray of light from a mirror.

If you drop a penny in a slot in an automatic machine, a box of matches is deposited in a little drawer, or a cigarette rolls out. This is a reflex action. The machine requires no mind or will. Mechanism is arranged in a certain way so that the weight of the penny must always produce the same result. If you pull the string of a shower bath, a stream of water descends. This is also a reflex action. No reflex action in the body is really so purely mechanical as this, but the illustration serves.



124. DIAGRAM OF THE BRAIN AND ITS VARIOUS REGIONS

The Medulla an Automatic Machine. The action of the medulla is under the control of the unconscious part of the mind, and it is therefore closely connected with the sympathetic system, which acts entirely without our knowledge. Of course, the value of this sort of action is immense. Were it not for automatic machinery, a man would have to be stationed by each box to hand out the matches or cigarettes as the pence were dropped in. Were it not for this system, life could not go on, for we could never carry on the processes of life as conscious and voluntary acts with the regularity and accuracy they require. We shall see the great value of reflex actions again.

The cerebellum is the site of the organ of equilibrium, and enables us to stand erect. It thus co-ordinates, or causes to act together, certain groups of muscles for this purpose. When diseased or paralysed, as by alcohol, a man can no longer stand upright.

Certain parts of the brain are specialised for a particular function, and the brain never acts together as a whole. The faculty of speech, on account of the interest which attaches to it, is a very good illustration of this fact.

The Centre of Speech. The centre of speech is situated just above and in front of the *left* ear. It is not on the right side at all. Here is the part that enables us to utter our thoughts, and from which power is given to the centres for the muscles of the mouth, throat, and tongue to formulate ideas into words. A blow here, of sufficient violence, perhaps depressing the temporal bone, or a disease of this part inside, would render a man speechless, whereas the same blow on the right side would have no such effect. But a blow of this force would most likely be followed by a further effect. The nerves of the body, as they travel to the brain, cross over from left to right, and right to left. So that the left brain, which is far the more developed, rules the right half of the body, including the right hand.

How the Right and Left Halves Differ. A blow of sufficient violence to injure the centre of speech would probably also paralyse the right half of the body, including the arm and leg. It is therefore a rule amongst medical men that if a man be paralysed down the right side, he is probably speechless as well. Whereas, if he be paralysed on the left side, his speech is uninjured, because then the injury is on the right side. But there is a remarkable exception to this. Certain people in the world are *left-handed*. That is, all that other people can do with their right hand they can do with their left. This is not the result of bad training, but it is *from birth*. The reason of the difference is that the two sides of the brain are transposed; the *left* brain is on the *right side*, and the *right brain* on the *left*. One finds, occasionally, the heart on the wrong side of the body in the same manner.

Now, these left-handed people, having their brains transposed, speak from the right side of the head, not from the left. If a violent blow be struck them on the left temple the right side of the body may be paralysed, but they will be quite able to speak; whereas, a blow on the right temple will not only paralyse the left side, as it does generally, but it will also render them speechless. There is one more curious fact as to speech. People who have been known to have the centre of speech incurably diseased or injured on the left side, may, after some time, slowly regain the power of speech and begin to talk again. It is believed that the right brain is, to a great extent, held in reserve to supplement the left, and that in such cases the right side slowly and gradually takes over the duties the left can no longer perform.

Functions of the Spinal Cord. Passing on now below the medulla, the functions of the spinal cord are of great interest, and are very varied in character. The *three chief functions* of the spinal cord as a nerve centre are (1) *conduction;* (2) *reflex sensation;* and (3) *reflex action.* In the previous section, from a different point of view, I have grouped the two reflex functions together, and added trophic and transferent functions, thus making four.

The spinal cord consists, as we have seen, of a right and a left half, joined in the centre by a bridge of grey nerve matter. A section of it in any part shows that, unlike the brain, it is white outside and grey within, the grey matter consisting, as I have said, largely of nerve-cells, and the white matter principally of nerve-fibres.

Nerves, when they pass into the brain or spinal cord, lose their sheath and white substance, and only the centre wire or axis cylinder is continued.

If any of the spinal nerves be cut across, both motion and sensation in the parts they supply are completely lost.

1. Conduction. The spinal cord, then, is largely made up of fibres that conduct impressions or impulses either of sensation up the cord to the brain by the posterior part, or of motion from the brain down the cord by the anterior part. The *sensory* nerves cross over to the opposite side of the cord as soon as they enter it, the *motor* fibres do so before they leave the brain in the medulla oblongata; so that the right half of the cord contains the motor fibres of the right half of the body, and the sensory fibres of the left half, and vice versâ.

2. Reflex Sensation. A good instance of this is when disease of the hip occurs, and the sensation of pain is felt in the knee. The sensory nerves of the hip and knee both run to the same part of the cord, and the sensation from one part is reflected to another.

3. Reflex Action. This is like that of the medulla, an action absolutely outside consciousness, and the necessary result of a certain irritation.

Movements may even have a definite purpose, like the beating of the heart or breathing, and yet be reflex, and without any exercise of conscious mind. Purpose in reflex action does not so much show the intelligence of the creature as of the Creator. One of the best instances of reflex action in the spinal cord is the knee-jerk, when one leg is crossed over the other, and allowed to hang loosely down. If the knee be struck with the edge of a book, or of the hand, the leg is at once kicked out, not only without the wish of the person, but even against it, so that the strongest will cannot prevent this reflex action from taking place. That this action is produced by the spinal cord is clearly proved, because, if it be diseased at a certain part, the leg no longer moves, however violently the knee be struck.

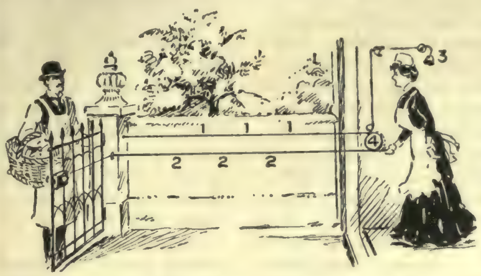
Conversion of Conscious to Reflex Action. We have already seen instances of natural reflex action, and of what importance they are to us. So valuable are they, indeed, that during the whole of our lives we are increasing the number of such acts; doing more and more complex movements without the aid of consciousness, and thus adding to those reflex acts which are born in us numbers of others which are artificial or acquired. It is probable that, as the lowest part of the cerebrum is the principal centre for *natural reflex action*, and the highest part for purely intellectual or voluntary or *intelligent action*, so the mid-brain is a great seat of *actions* once voluntary, but which have *become reflex.*

At first, nearly every action is the result of direct will and mental effort. Watch a child learning to walk. It is as hard as learning Greek is to us; each step is considered and taken with great difficulty. In six months, however, it has so become a matter of habit as to be reflex—that is, to be conducted outside conscious will action, and the cortex is set free from thinking *how* to walk, which absorbed it at first, to consider *where* to walk to, or to intelligently direct this new reflex habit. The same occurs with reading and writing, and every other oft repeated act. At first, all the mind is concentrated on *how* to read and *how* to write—*what* is read or written is of small importance. It is the connecting of certain letters with certain sounds, and certain sounds with certain shapes, that is at first such a severe mental effort; and yet so easy does it become by frequent repetition that after some time we never think of the separate letters, even when we write them, but writing and reading become acquired reflex habits the mind being wholly absorbed in what is read or written. The habit of swinging the right arm forward with the left leg, and the left arm forward with the right leg is so strong that it is the hardest thing in the world to swing the right arm and leg both forward together. It is, indeed, almost impossible, although we think we have complete control over the muscles of our limbs.

Acquisition of Good and Bad Habits. This leads us to another point. A natural reflex action *cannot* be overcome; an artificial reflex habit can be overcome, but it is *very hard.* Swearing, for instance, soon becomes an artificial reflex habit and the mind never thinks of it at all. An oath comes out at slight provocation, and we may not even know that we have sworn. To break such a habit is very difficult, and once we have allowed an action to become a reflex habit, it is the hardest thing

in the world to conquer. Let us give here a favourite illustration of this [125].

Houses with long gardens in front have often latched gates by the road that can be opened by pulling a handle in the hall, which raises a latch by a wire running down the garden and saves a long walk along the path. The front-gate bell also rings in the hall. Now, if the gate bell rings, it is just like a sensation reaching the upper brain from some part of the body. The mind at once is conscious of it, and attends to it, just as the servant comes into the hall, opens the door, and looks down the path to see who is at the gate, and thus she decides whether to open the gate or not. If she pulls the handle, and it lifts the gate latch, anyone may enter. So in the brain the message may be, "Someone is treading on my foot." The mind looks out of the windows (the eyes) to see. If it be a stranger, the order goes to the muscles, "Draw the foot away;" if it be a friend, the order may go to the muscles of the voice to say "Why did you do that?" Now this is a *voluntary* action in both cases. But suppose the servant be lazy or busy, and cannot be bothered by running to bells all day, and suppose she ingeniously connect the bell-wire with the wire that lifts the latch round a pulley in the hall. Now when the bell is pulled it does not ring, and the servant (the mind) can hear nothing (is not conscious of it), but the pull raises the latch of the gate and lets anyone in. This is how a voluntary act is changed into an artificial reflex habit. Now consider the advantage of this. The servant is free to do other work, there is no worry of bells ringing, there is no delay in getting in. Observe, on the other hand, the disadvantages. Anyone can now get into the house, for the servant has no control or choice in the matter,



125. ILLUSTRATION OF ACQUIRED REFLEX ACTION

1. Afferent wire, or sensory nerve 2. Efferent wire, or motor nerve 3. Bell, or conscious centre in brain 4. Pulley, or acquired reflex in mid-brain

Hence we conclude that nothing is of greater value than the formation of as many good habits, or acquired reflex actions, as possible; and nothing is more dangerous than the formation of bad ones.

Cause of the Growth of Habits. The artificial reflex habits of which we have just spoken are believed to be formed in the brain by the growth of nerve-fibres between groups of cells frequently used for the same purpose.

Thus *A*, *B*, *C*, and *D* are nerve cells. *A* moves the right arm, *B* raises the left leg. The habit of moving the right arm when the left leg is raised has been performed so often in walking that a connection has been formed between *A* and *B*, and the artificial reflex habit acquired of moving the two together.

C controls the thumb, *D* controls the movements of the finger. The two so often go together in the same position in holding a pen that a nerve connection has been set up between them, making the act of holding a pen an artificial reflex habit.

We have compared the brain to the dark forests of Africa, but may here give a more homely illustration. Across a common covered with gorse and heather, paths are soon formed between the cottages built at one side, the public house at another, and the school and the general shop somewhere else. These paths always lead in the directions most often used, so that it is much easier to walk in them than over the heather and gorse. Education not only stores our mind with knowledge, but makes certain actions in our life easy to us, by forming artificial reflex habits.

Difficulty of Eradicating Habits. Let a town labourer change places with a fisherman. The latter will sicken and die over the unaccustomed labour in town, while the town labourer will find the fisherman's work impossibly hard and dangerous, and the exposure will probably kill him. There are no connections in their brains between the cells that have to perform the novel work of the other. It is not really a question of physical weakness, but of want of acquired reflex habits.

This shows how important it is for everyone to enter his trade or profession early in life, and not to change it afterwards. Look at a girl learning a mechanical habit, such as knitting, and observe how she thinks over each stitch. She cannot talk, she is too busy, and yet she knits very slowly; but by degrees, as the connections begin to be made between her cells, and fresh paths trodden across the "common" of her brain, the work gets easier and easier, and at last her fingers go so fast you cannot see them, and yet she can talk all the time, and does not even require to think what she is doing.

Three Actions of the Brain. The actions therefore of the brain are three in number:

1. VOLUNTARY AND CONSCIOUS, always proceeding from the cortex, which may be merely abstract action of the thought centres or the purposive physical replies to sensations of light, sound, or common feeling.

2. ACQUIRED OR ARTIFICIAL REFLEX acts which are mostly unconscious and connected with the mid-brain, and largely consist of actions purely voluntary which by continual repetition have passed out of consciousness, and are no longer sent up to the cortex [see diagram 124], but are short circuited in the mid-brain.

3. NATURAL REFLEX actions entering outside conciousness, and connected with vital physical processes, and mainly centred in the lower brain, or medulla, and the spinal cord.

Continued

THINKING & CONCENTRATION

Memory and Attention. Linking up Memory with Consciousness. Training the Memory. The Necessity for Selection and Concentration

By HAROLD BEGBIE

ONE of the profoundest mysteries of human personality is the faculty which we call memory. This faculty has been defined as "the mental capacity of retaining unconscious traces of conscious impressions or states, and of calling these traces to consciousness with the attendant perception that they (or their objects) have a certain relation to the past." Locke defines memory, in "Human Understanding," as "the power to revive in our minds those ideas which, after imprinting, have disappeared, or have been, as it were, laid out of sight."

The phrase "laid out of sight" forces on the studious mind the mystery of memory. There is a department of our mental machinery which retains images, ideas, and impressions. It is a department of our mental machinery which is not included in that more obvious department which we call normal consciousness. Our normal consciousness does not keep a perpetual memory of all its impressions. Challenged to repeat or to relate one of these impressions, normal consciousness has to apply to another department of the mind for the necessary information. Separate altogether from normal consciousness, and yet (when properly trained) in sympathy with that normal consciousness, is the vast and almost unexplored department of human consciousness which keeps the tablets of experience.

Neglect of Early Training. Our business here is to show in what manner the sympathy existing between the normal and the secondary consciousness may be so strengthened as to keep the normal consciousness constantly informed with the knowledge of the secondary consciousness.

Some men are born with this strong sympathy, and are spoken of enviously as possessing wonderful memories. But in most cases of *bad* memory the effect may very frequently be traced, not to an imperfect physical organisation, but rather to neglect of training in childhood. It is certainly uncommon to come across a really well-trained and efficient man who is not gifted with a smooth-working and precise memory.

There are many men who profess to educate people's memories. They have some mental gymnastic or some particular dodge by which they affirm that it is possible for anybody to remember anything. These gymnastics and dodges have rightly been denounced by Fitch as "mere processes and a sterile mnemonic." No mnemonic words and no mnemonic lines can ever permanently strengthen that extreme sympathy between the two orders of consciousness without which no man can possess a really efficient memory. How, then, can they be strengthened? How is it possible for a person who finds difficulty in remembering names and dates, people and scenes, books and impressions, to link up his consciousness with his memory so as to be able to recall any of these impressions and experiences at the immediate desire of his will?

Training the Memory. We believe there is only one sound method of "training the memory," and that is by systematic use of information acquired and impressions received. The "things laid out of sight," that is to say, must every now and then be looked over. As a good housekeeper looks over her store cupboard or linen-chest, so every now and then must the student go over his store-house of impressions and ideas. He must continually be taking stock of himself, continually be making use of his knowledge.

A person with a bad memory (which means a person whose lines of mental communication are weak) is very often far more impressed by a particular thing than one whose memory is good. A person with a bad memory may be far more moved by "Lear" or "Hamlet" than a person with a good memory; but the person with a good memory, after reading these plays, is able to quote certain lines and to tell the movement of each drama in the precise sequence of the poet, while he of the bad memory will jumble the lines of one play with the lines of the other, mix up the movement of one play with the movement of the other, and find it impossible to give any precise account of the two dramas.

And yet the secondary consciousness of the man with the bad memory probably retains a far sharper image and a far more delicate appreciation of the dramas than does the secondary consciousness of the man who can so glibly recite his impressions, and with such admirable ease. The problem, then, for the man with the bad memory is how to establish better communication between his normal and secondary consciousness. He must be careful to remember that his memory retains an absolute impression of the drama, and that it is only his capacity to call up those impressions which is so seriously at fault.

The Uselessness of Memorising. To learn any portion of these plays by heart is not a good practice. Verbal memory is not real memory. The remembering of words and lines is an act, it is not a continual correspondence between normal and secondary consciousness. Far better than "memorising" words and lines, as it is called, is the habit of *thinking over* a scene. It is a curious fact that people with bad memories are nearly always impatient thinkers.

Like a hot-headed soldier, they rush through the country of new experiences without troubling to establish lines of communication with their base. This means intellectual destruction. Every step taken in knowledge must go with a strengthening of the lines of communication. And the lines of communication are Thought.

Reading and Thinking. We believe that a child's memory can be trained by making it discuss what it has lately read or seen, making it think. By this we do not mean that parrot-habit of question and answer between teacher and pupil, but rather an intellectual talk in which the teacher skilfully induces the pupil to speak about what it has lately been considering. In like manner the adult student may cultivate a good memory by immediately going over in his own mind some chapter in a book, or some scene in a play, which he has just read. He will have to check in himself the feverish desire to race through the book—curiously enough, paradoxical though it may seem, the chief passion frequently of people with extraordinarily strong memories, and therefore weak lines of communication.

A mind that receives sharp images is always eager to receive more, and goes rushing on without pausing to see that the lines upon which these images travel from the secondary to the normal consciousness are established. It is the person whose mind does not receive sharp images who reads ploddingly, and carefully impresses on himself the need of remembering what he reads.

Impatience, then, is the first obstacle to be got out of the way. Slow reading, frequent pauses for reflection, and regular intervals for going over in the mind the images received are the best means of establishing our mental lines of communication. The student will also find it useful to discuss as frequently as possible the matter with which he has engaged himself. Conversation is the examiner of our minds. Another useful exercise is the writing down of impressions, and this is one which should regularly be employed. In writing the brain is quieter, for the eye is undistracted, and it is only in such a condition that lines of communication can be established. As the exercise is more and more employed it will be found that more and more impressions return to the normal consciousness.

The Necessity for Selection. It is a helpful habit after witnessing a scene to close the eyes and strive to see it once again with the mind's eye. After this a verbal description may be given to a friend; and after that a written description should be made of the same scene—each exercise bringing out increasingly the details and the colour and the movement of the whole impression.

The act of forgetting is a great help to the act of remembering. Here the necessity for selection comes in. It is a fatal practice to load the mind with the burden of unessentials. It is a most useful practice, strengthing both the memory and the balance of the mind, to select consciously essential things for remembrance, and to discard consciously everything else. Any laboured effort to "memorise" in a wholesale fashion is to be reprehended; its result can only be a confused and chaotic storehouse of information out of which can flow no ordered and definite impressions to the normal consciousness. Intense interest in a subject, together with observation and criticism, will build up a discreet memory, and keep open the lines of communication. In other words, *thinking about a thing* establishes between the normal consciousness and the secondary consciousness a certain and an absolute sympathy concerning it.

Does Memory Know all Things? We cannot leave out from this article, although the subjects are treated in their proper place elsewhere [see PSYCHOLOGY and PHYSIOLOGY], the psychical and physiological sides of memory. There is the definite act of recalling an impression, and there is the "subliminal uprush" which presents to consciousness some experience on our part of which we had entirely forgotten the knowledge. Everybody is aware of these marvellous pictures which suddenly glow before the eye of consciousness and make the far past, for a single instant of time, as vivid as the present. Men have related that in moments of great danger—such as drowning—their whole past life has flashed before them, and it is a common experience of anæsthesia to relive in the few moments of the anæsthetic's power over our consciousness long years of our life, with every incident as vivid and as detailed as it was in the past.

By these experiences we are able to perceive that the memory of man is perfect. Every picture is photographed indelibly, every sensation is recorded infallibly. Nothing can happen to us — no great emotion or passing and elusive sensation — which is not faithfully treasured in the memory. And if, as certain men of science declare, the memory inheres "in a single cell, or neuron, or even in a single living molecule," we may feel disposed to answer that there must then be in us a perfect memory of not ourselves alone, but also of the lives of our fathers and our forefathers to the creation of the world, since that single cell or neuron has descended unto us from the first and parent cell of conscious existence.

Thinking about Things. But we find difficulty in remembering early events in our life. No man can go back to the memory of his own cradle. Few men can remember the first word they spelled or the first sensation they consciously received. The memory in each one of us—descended from endless ancestors—may, or may not, retain the impressions of our infancy and the memory of creation's past; but, at least, we know that we ourselves have no power over that memory, cannot exercise any dominion over it, concerning any of the impressions it recorded before we ourselves became definitely aware of conscious thought. From this we see that thought is the great rivulet which flows from the spring of memory to the tap of consciousness. Thought

draws the water from the well, and brings out of the hidden places of our being the refreshment which we call memory. By thinking about things (not by learning things by heart) we cultivate increasing sympathy between the secondary consciousness and the normal consciousness. The dazzling uprushings of genius, concerning which Frederic Myers has written with such amazing lucidity, belong to the subject of Memory, but cannot be explained. It is permissible to think, however, that these subliminal activities are the result of thought in the past—not necessarily thought of the particular thing, but the habit of thought which has so perfectly placed in sympathy the memory and the normal consciousness that impressions travel easily and continually from the one to the other.

We believe, then, that just as the habit of thought creates the ordinary good memory of the average efficient and capable man, so that same habit carried to perfection creates that wonder and mystery of the world, a genius. The whole secret of the application of our education, and the use of our experience, lies in the creation of entire sympathy between the memory and the normal consciousness, and this sympathy can only be established by perpetual thought and regular self-examination. Let it, therefore, be seen that the matter is not one of training the memory (the memory, in all probability, being a more or less perfect record of our experience), but rather one of establishing between the memory and the normal consciousness, which calls itself "I," a channel of communication and an intensity of sympathy. To do this we must cultivate the habit of continual thought.

Concentration. It has been said that even the most earnest and pious person cannot say the Lord's Prayer without a wandering thought. The reason is simple enough. The mind is influenced by the association of ideas. A word, a phrase, a movement, a scent, is sufficient cause to set the thought of a mind following that particular thread through the labyrinth of its memory. To concentrate the thought upon a single thing, without following any of the by-paths suggested at every movement along that one and definite road, is an exercise of will requiring the greatest strength and the most sustained effort.

And yet this concentration of the mind is one of the essentials in an application of education to the affairs of life. No man can hope to puzzle out a problem, to invent a new thing, to improve upon existing things, or to reveal any new aspect of truth, unless he has it in his power to concentrate his whole mind upon the matter in issue.

Can he, then, learn to acquire this definite and decisive control over the machinery of the mind? It is possible, we believe, to teach children the habit of concentration, but in the case of an adult conscious of no particular interest in life the process is one of great and almost overwhelming difficulty. Unless, indeed, the desire to acquire concentration is sincere, every effort will be in vain; and both in the case of the child and of the adult there must be interest in the subject on which concentration is desired. Given, first, an eager desire to acquire absolute control over the machinery of the mind, and secondly, the opportunity of practising on some favourite subject, there is no reason why an adult should not learn, at least in some degree, this "one pre-eminent habit of education."

The Old Way and the New. According to Mr. Francis W. Parker, Principal of the Chicago Normal School, who has written exhaustively on this subject, the education habit of attention, or as we put it, concentration, "is purely a cultivatable one."

"In simple spontaneity," he says, "without direction, there is very little development of the habit of attention. There may be many acts of attention, but they cease before they reach the education point, or they have no organic relation each to the others. The cultivation of the habit of attention is the main factor in education; the habit of observing closely, listening intently to language, and of reading intensely, are the fundamental means by which self-activity is induced and developed."

The Americans have developed, or perhaps we should say are developing, a system for cultivating the habit of attention. Like everything else which comes from America it is not new, but is rather a swift and revivifying development of something old. In the present instance, the American method is an improvement on an Asiatic method which has been in use among the Buddhists for countless centuries. The Buddhist gives a pupil a stone, bids him hold it in his hands, and cautioning him against lifting up his eyes from the object, instructs him to fix his thought to the stone and to hold it there with the tightening force of his will.

The American, on the other hand, gives his pupil an orange, and bids him look well upon it. After that the pupil is allowed to model the orange, then to paint it, then to draw it, and then to study it. As soon as the shape, the colour, and the character of the orange has been mastered, it is peeled, and the skin is observed with minuteness. Then it is cut into parts, each part is examined, and then the pulp and seed are observed, drawn, painted, and descriptions given of them in writing.

The Secret of the New Way. The difference in these methods will be appreciated at once. In India the fakir may be seen who has clenched his hands until the nails have grown through the palms and thrust themselves through the backs. In America the man may be seen who has learned to make an eternal record of the human voice and who has harnessed electricity to the service of mankind.

The secret of the American success in this method lies in the selection of the subject on which we seek to practice concentration. If you detest theology, it will not help you to concentrate your thoughts by listening to sermons. If you have no sympathy with music, the effort to concentrate your mind upon the logic of a music lecture will not help you one

whit. If you are fond of flowers, do not try to concentrate your thoughts upon postage-stamps, and if you are fond of postage-stamps do not labour to concentrate your thoughts on electrical machinery. Whatsoever is your favourite subject, or the theme in which you fancy you have most interest, in that learn to acquire the educative habit of attention.

Self-examination. And yet there are many people who confess their inability to give their attention to anything, and who complain that it is impossible for them to acquire the habit of concentration, since any object dwelt upon for but a few minutes irritates the consciousness and arouses antagonism. For such as these, as we said at the outset, the path is beset with extremest difficulty. The great cities of the world are overcrowded with young people capable of not ten minutes' concentration. Whatever work they do, they do without delight, their thoughts wandering aimlessly through a chaos of mental impressions, the machinery of their mind running on without control of any kind—derelict intelligences. They experience in their lives neither exultation nor delight ; they have no knowledge of real pleasure and real enthusiasm ; the beauty and the splendour of the natural world, and the glories and the conquests of the intellectual world, have no significance for them. Beyond the ordinary pleasures of the physical organism, which we share with the animals, they know of no satisfaction.

In cases of this kind, the habit of attention can best be created by occasional exercises in intellectual egoism. The derelict intelligence, anxious to acquire the habit of concentration, and yet professing that it has no subject on which it cares to fix its attention, must begin with itself. Let such a man examine himself, dwell upon himself, analyse and dissect himself. Let him begin by learning to observe himself. Why does he do such a thing ? Why does he permit himself such a habit ? Why does he go to such a place ? By repeated questions of this kind addressed to himself, he may arouse out of its suffocating torpor the will which has ceased to direct his volitions. At every turn of his day he must learn to be observing himself by means of questions. Haply, in the end, this morbid self-examination may lead to such disgust with himself that his consciousness, taking upon itself new strength, will fling off the mental torpor which has obscured his intelligence like fumes of wine, and take possession of the machinery of his mind, controlling it and guiding it to conscious ends.

The habits of reading intently, of conversing intently, of listening to spoken words intently, help to build up the properties of concentration.

Do it With Thy Might. We should do all things with conscious direction. The negation of concentration is slackness. To read slackly, to talk slackly, to listen and to observe slackly, is to loosen all the muscles and fibres of intellectual alertness. The student must for ever check in himself any slackening of interest. If he is reading, and the subject begins to pall upon him, he must shut the book and turn to some other subject which will arouse his interest again. Whatever he finds to do, he must do it with all his might.

In exercises of contemplation, it is important that he first consider what he will observe in any particular object—its form, its colour, or its sound. His thoughts must all be regular ; every fresh apprehension must arise from some definite act of attention. For instance, he must become aware of some particular curve in a butterfly's wing while fixing his attention on the form of the insect ; he must become aware of a particular shade of green in the wing while fixing his attention on the colour of the insect. He must correct in himself the haphazard working of the mind, the spontaneous flight of his attention at every glance of his eyes. The mind must follow the orderly course of his system of observation, and must work always under his conscious control.

Wordsworth's "Wise Passiveness." While our object is to show here some of the chief and most useful methods of learning the art of concentration, and while we believe that this is indeed one of the pre-eminent habits of education, still we must attest our faith in the Wordsworthian theory of a "wise passiveness." There are certain natures of a highly intellectual order to whom concentration must always appear an irritating impertinence. And if to these people—generally people of some creative ability—ideas of a luminous kind come in their states of passiveness, streaming in upon them as sunlight streams into the morning, we may be sure that Nature does work in this direction, as well as in the more definite and decided fashion of directed energy. Therefore, it is good, even for the man who practises exercises of concentration, to permit himself certain minutes of passiveness, wherein he allows to flow freely into his soul the breath and secret influences of his surroundings.

Moreover, it is in moments of this kind that he will most easily gather the fruits of his concentration, for the mind gives nothing which has not first entered it, and the most glorious of "subliminal uprushings" must, we believe, have at least some part of its origin in our own observation and experience. If we are always acquiring, we shall never invent ; if we are always observing, we shall never create.

However, the mind cannot be damaged, nor the play of the soul be hampered, by a continually increasing closeness of observation ; and by this means, more than by any of the more elaborate exercises of professors on this head, however valuable they may be, the habit of the most useful concentration—the concentration leading to creative activity—may best be acquired.

Continued

NINETEENTH CENTURY PROSE

A Preliminary Sketch of the Period, together with a Study of Some of the Principal Essayists and Critics. "The Renascence of Wonder"

By J. A. HAMMERTON

NINETEENTH century prose, infinite in its complex variety of style, is distinguished by the common characteristic of critical inquiry: it aims at truth; it strives to touch the very heart of life. There are, as Goethe said, many echoes, but few voices. This is largely true of all literary periods; but the voices of the nineteenth century will compare advantageously with those of any preceding period. Where prose is concerned they are heard at their best, perhaps, in the novel. But the "new note" is hardly less resonant in the essay, the biography, the history, the book of theology, the narrative of travel, the scientific treatise, the studies of philosophy, art, education, politics, and economics.

If the twentieth century has opened for us with a wider and a nobler outlook on "the things that matter," it is due largely to the work accomplished in the preceding century in the domain of English letters, when our great writers took to heart the aphorism of an eighteenth-century poet. They saw with Pope, but with a finer insight than his, that "the proper study of mankind is man." The literature of knowledge and the literature of power belonging to this period are alike marked by the dominating but informed interrogative, for it was not only in imaginative writing that the last century witnessed what Mr. Watts-Dunton has called "the Renascence of Wonder," but in all fields of literature—in criticism and science, not less than in poetry and romance, this re-birth of "wonder" took place. The originator of the phrase thus explains it: "The Renascence of Wonder merely indicates that there are two great impulses governing man, and probably not man only, but the entire world of conscious life: the impulse of acceptance—the impulse to take unchallenged and for granted all the phenomena of the outer world as they are—and the impulse to confront these phenomena with eyes of inquiry and wonder."

"The Renascence of Wonder." Before studying the effects let us glance at the causes of this change in the nation's literary life. The French Revolution shattered the scholastic formalism of English letters. Jean Jacques Rousseau stirred up a feeling for humanity such as England had never before acquired from French or Italian writers, much as she had been influenced previously by Continental models. The effects of the Red Terror threw the thoughtful back for a time into the slough of despond. We have seen how Wordsworth, for example, was bowed down in this way. Then a Scottish teacher read Mme. de Staël's "De l'Allemagne," set himself to master the German language, put Jean Paul Richter in the place of Jean Jacques Rousseau, and by the exercise, on the one hand, of the extraordinary knowledge he acquired of German philosophy and German individualism, and his painstaking elucidation of the Cromwellian epoch on the other, set aloft an ideal of manhood and patriotic duty which, faulty in many respects as the design may have been, influenced materially the popular view of history and the outlook on nature There were others who drank deeply at the Teutonic spring. Wordsworth was one of these, Coleridge was another, Byron a third; Scott and De Quincey were also of the company. Each was affected more or less differently, but at the same time profoundly. A new spirit was introduced into our literature—the spirit of wonder, which is of all human characteristics the most natural, the most fruitful in its influence not merely upon literature and the other arts, but upon every work of the hands of man. Had there been no "Renascence of Wonder," we had seen few, if any, of the marvellous inventions which rubricate the nineteenth in the calendar of the centuries. Thus it was that romance was reborn; that metaphysics acquired a new meaning; that humour was reincarnated. Men longed to look at things as they were; to see them "whole." Carlyle entered as an iconoclast into the temple of "the Gigmanities"; and of all the masterminds of the century, he is the one who, both directly and indirectly, has stirred most deeply the heart of the vast reading public called into being by the mechanical inventions of what Dr. Russel Wallace has called "the Wonderful Century."

Literature and Politics. The history of the essay, both critical and constructive, in the century we are considering, is bound up with the history of the periodical.

Something of the same kind may be said of both poetry and the novel. The various periodicals having a political bias, if not basis, literature developed more or less under the ægis of politics. The writers made the reviews and the reviews helped to make the writers. If the student, happily versed in more modern literature, approaches some of these old masterpieces in a spirit of wonderment at the fame attached to them, he must try to forget his later knowledge. He must look at the work with the eyes of the generation upon which it was sprung with such magnetic effect. Herein lies the value of the historical and comparative method in the study of all literature. To-day much of the vital force which animated the work of earlier writers has been scattered, much of their "thunder" has been stolen, the knowledge in the light of which they wrote has been found to be misleading. But the saving salt of an individual

style preserves many an old and obsolete book from the blight of oblivion.

Styles of the Great Writers. Among the influences on later prose must be remembered the prose of the poets—the prefaces of Wordsworth, the miscellanies of Scott, the critical essays of Coleridge, the letters of Byron, Shelley, and Keats. But the student has a wonderful variety of object lessons in style before him, apart from these great names. There are the Puritan fervour and grim humour of Carlyle, the gentle intimacy of Charles Lamb, the graceful confidences of Leigh Hunt, the aerial cadence of De Quincey, the emphatic, unmistakable vigour of Cobbett, the brilliant antitheses of Macaulay, the incisive phrases of Hazlitt, the wit of Sydney Smith, the beautiful imagery of Ruskin, the flowing sea-music of Swinburne, the classic beauty of Landor's dialogues, the perfect serenity and harmony of Newman, the scholarly prose of Matthew Arnold, the undecorated diction of Hallam and Freeman, the picturesque pages of Froude, the jewelled sentences of Walter Pater, and the sparkle of Stevenson. In the main the prose writer who aspires to style must be an artist just as the poet is an artist, but the secret of style is, ultimately, the harmony between the subject and its treatment.

Literary Style. For general purposes style has been considerably influenced by the usage of journalism. The Press is responsible for a marked lessening of the distinction between written and spoken language. There must always be some distinction between the two. The skilled writer must of necessity possess a close acquaintance with the meaning of words; and it is, perhaps, a defective knowledge of the meaning of words which lies at the root of most failures in composition. The speaker, by means of accent, emphasis, look, gesture, personality, can lend significance to a comparatively poor speech. The writer, if he would impress his readers as effectively as the speaker impresses his audience, must find literary equivalents for the methods and circumstances of platform and pulpit. But the aim of the writer who addresses himself to a wide public should be directed to the perfection of a style that shall be distinctive—a copied style is but a mask—clear and colloquial, yet avoiding baldness and vulgarity, and from which foreign words, once so plentiful in the "spotted Dick" period of English prose, shall be notably absent.

Biographers and Historians. While the essayists have done much to increase our knowledge of bygone, and particularly of Elizabethan, literature, as well as to popularise various branches of scientific learning, the biographers have given to the prose of the period some of its greatest intellectual assets. Southey's "Nelson," Lockhart's "Scott," Carlyle's "Cromwell" and "Sterling," Lewes's "Goethe," Froude's "Carlyle," Masson's "Milton," Spedding's "Bacon," Stanley's "Arnold," are classics that for one reason or another are never likely to be superseded. The influence of English historical methods has been world-wide. The nineteenth century historians are worthy successors of Gibbon. They have determined the unity of history, brought the study of evolution and environment to a pitch of scientific accuracy, and made history a fascinating study.

Theology and science, philosophy, politics, economics, art, education, and travel will be briefly touched upon in our chronological study of the leading prose writers of the period. There remain, however, before we take up this chronological study, two facts of especial interest that must be noted. One is the high literary value of much of the scientific literature of the time, as disclosed, for example, in the writings of Huxley; the other is the distinction attained by women writers. The latter is a portent that should commend itself to some philosopher of the future; its ultimate significance is hidden from our ken.

Essayists and Critics. No serious student of English criticism can afford to neglect the prose writings of SAMUEL TAYLOR COLERIDGE (b. 1772; d. 1834). They are by no means easy to read at the outset, but when the author's point of view has been attained they will prove most stimulating and suggestive. The "Lectures and Notes on Shakespeare" are especially valuable both on account of their great intrinsic value and the effects they had on later estimates of the national poet.

SYDNEY SMITH (b. 1771; d. 1845), FRANCIS LORD JEFFREY (b. 1773; d. 1850), and HENRY PETER LORD BROUGHAM (b. 1778; d. 1868), were jointly responsible for the early numbers of the "Edinburgh Review." They were politicians first and men of letters in a secondary sense. Sydney Smith's was a natural wit, but it was always under the control of good taste. His style was natural, and he used with unequalled effect against the forces of pretence and pomposity the process of logical inquiry known as the *reductio ad absurdum*. Jeffrey was master of a style the importance of which is derived from the fact that it served as a model to his greatest contributor, Macaulay. Brougham's zeal for popular education was greater than his discretion as a critic. WILLIAM GIFFORD (b. 1756; d. 1826), the first editor of the "Quarterly Review," was another "man with a bludgeon," whose best services were those he rendered to the Elizabethan dramatists and especially to the memory of Ben Jonson. Few men whose names are remembered in literature ever wrote more that has been forgotten than did ROBERT SOUTHEY (b. 1774; d. 1843). His fertility of production was as amazing as its variety. He was a scholar, and, considered as a stylist alone, claims a high place among his contemporaries. And yet "of what is called style," he said, "not a thought enters my head at any time. I only endeavour to write plain English and put my thoughts in language which every one can understand."

SIR WALTER SCOTT (b. 1771; d. 1832) wrote almost as incessantly and as variously as Southey, but with much greater success, independently of his greatest work. His essays on chivalry, romance, and the drama, and his letters on demonology and witchcraft are still eminently readable; and he was a painstaking as well as a capable

editor, especially of Swift. JOHN WILSON (b. 1785; d. 1854), the "Christopher North" of "Blackwood's Magazine," is chiefly remembered as the literary parent of De Quincey, as part author of that brilliant series of dialogues, "Noctes Ambrosianæ," and author of a work entitled "Lights and Shadows of Scottish Life." JOHN GIBSON LOCKHART (b. 1794; d. 1854), Scott's son-in-law, and Wilson's friend and colleague on "Blackwood," who succeeded Gifford as editor of the "Quarterly," gave to journalism much that by right should have been devoted to literature. His masterpiece is the "Life" of Scott, second only to Boswell's "Johnson" as a model biography. Every student must read it, but may neglect his novels, though "Adam Blair" is worth reading if one should come across it.

Charles Lamb. One of the greatest, as he is one of the least pretentious, of English prose writers, is CHARLES LAMB (b. 1775; d. 1834); but the now world-famous "Essays of Elia" originally issued from the press, at all events in their collected form, upon a cold and irresponsive world. In the history of English prose Lamb stands as much alone as Landor or Sir Thomas Browne. He is master, not of one style, but of as many styles as he possessed moods. He is full of elusive echoes of the old writers whom he loved. His is the art that conceals art, for seemingly he is as frank and as communicative as Montaigne. His character is written in his "Essays"; his autobiography in his Letters. He wrote for magazines—the "London" in particular—but he wrote what he would, and not merely or principally for the pecuniary proceeds of literary work. Herein, undoubtedly, lies part of the secret of his enduring charm. Then, he was a man of many friends. His life-story is as inspiring as that of Scott. Posterity reverences Lamb almost as a memory of a golden age, as the embodiment of a quality of heart from which it has parted; it looks on him as Lucifer looked on Paradise lost. But Lamb was not only an essayist of unique charm; he was also a critic of rare insight and surprising accuracy. Nothing that he wrote, and wonderfully little that his life inspired others to write of him, can the student afford to neglect.

William Hazlitt. In WILLIAM HAZLITT (b. 1778; d. 1830) we have a strong contrast to the man who regarded him as "one of the finest and widest spirits breathing." Hazlitt was indebted to Lamb, and acknowledged the indebtedness; but with a critical faculty as keen as that of Lamb, he possessed not a scintilla of "Elia's" human sympathy; hence, whereas the one is loved the other is given the meed of almost frigid praise. Yet Hazlitt's is a name of first importance. "We are mighty fine fellows," said Stevenson, "but we can't write like William Hazlitt." He is the master of the apt and illuminating phrase. The student of Shakespeare owes much to Coleridge's "Lectures," he owes much also to Lamb's "Critical Essays," but he must also study, and study with attention, Hazlitt's "Characters of Shakespeare's Plays"—a work dedicated to Lamb—and the "Lectures on the Dramatic Literature of the Reign of Elizabeth." Of equal note are the "Lectures on the English Comic Writers" and "Lectures on the English Poets." It must be confessed, however, that there is more venom than justice in the personal sketches he called "The Spirit of the Age." But, as a recent writer in the "Quarterly Review" well says, noting the haunting motto prefixed to the delightful essay "On Sundials," "if one only counts Hazlitt's serene hours, they prove him to have had something far higher than the talent which does what it *can*. He had his share—no one who has tasted the fruit of those serene hours can gainsay it—of the genius that does what it *must*."

Thomas De Quincey. An object of the most contradictory criticisms is THOMAS DE QUINCEY (b. 1785; d. 1859). Sir Henry Craik, in his introduction to the final volume of "English Prose Selections" describes De Quincey's prose as spurious, and as possessing "all the appearances of eloquence except those that are true." Further on in the same work Mr. R. Brimley Johnson, who alludes to De Quincey's "vigorous intellectuality," "genius," "richness of fancy," and "splendour of style," says: "Exactness, carried to the verge of pedantry, is the conspicuous merit of his style, which is further strengthened by a scrupulous attention to the conditions of effective comparison, and by the explicitness with which his statements and clauses are connected." With Hazlitt and Lamb, De Quincey was a contributor to the "London Magazine," in which his "Confessions of an English Opium Eater" appeared. De Quincey stands sponsor to the modern school of "prose poets" of which Mr. Swinburne is the great exemplar. He has much to attract, but is dangerous to follow. He lacks a certain dignity, is normally without what we understand by the word "reverence," and he is at times terribly discursive; but we must remember that the bulk of his work, which has been collected in nine volumes, was anonymous journalism, and that the writer kept up a weak physique by the use of opium. The "Confessions," the historical essays, "Levana; or, Our Ladies of Sorrow," and the "Autobiographic Sketches," should be closely studied. De Quincey has been styled the "Boswell of Essayism," so intimate are his revelations of both himself and his associates. He possessed to an almost amazing degree an instinct for dramatic expression. Whatever some of whom he wrote may have thought of his character drawing, he was well liked personally, and in his later years he proved a good husband and a devoted father. Perhaps Mr. Birrell is right when he declares that De Quincey will always be "above criticism." This great essayist was a rhapsodist, but he was, too, an inquirer, and his influence was against cast-iron formality in English prose.

Continued

VIOLIN PRACTICE

Intonation. Major, Minor, and Chromatic Scales. Time Table for Practice. How to Clean the Instrument. Intervals

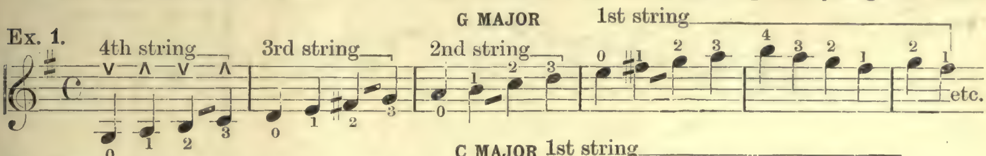
continued from page 2125

By ALGERNON ROSE

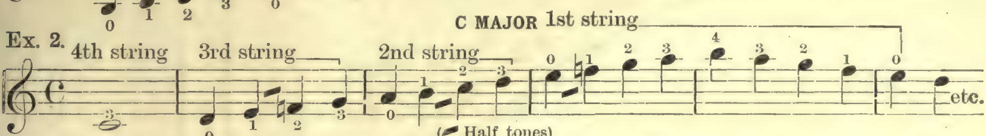
REFER to the keyboard of a piano if there is any doubt about getting the right notes. Of equal importance with the time-sense for the violinist is the necessity to play in tune. Accurate intonation in fiddle playing must be cultivated assiduously. Gradually the ear will become accustomed to the correct intervals, and identify them without the aid of a piano. If it does not, the student had better learn a keyboard instrument, on which the intonation of the notes is furnished mechanically.

Slowly and firmly try the scale of G major. Begin on the fourth string with a down-bow and sound the open note, G. If a bar usually begins with a down stroke because of the pressure being stronger, it finishes, as a rule, with an up-bow, the last beat being less accentuated than the first. Put down the first finger near the head so as to stop the A above the G. Play this with an up-bow. Place the second finger on the string to sound B. Bring the bow down resolutely. To get the semitone above for the note C, put down the third finger close to the second. Play with an up-bow. The neighbouring open string supplies the next note, D. Having bowed this, put the first finger on the third, or D, string to get E. The second finger will produce F♯, and the third, close to the second, the G♯ above. Never raise a finger already down, unless for the production of a lower note on the same string, or a note on another string. The second string gives the open A, the first finger on it the B, the second C close above, and the third D. Lastly, the first string furnishes the open E, the first finger F♯, and the second, close to the first G♯. Go down the scale in the same way. Count with each sweep of the bow [Exs. 1 and 2].

Ex. 1.

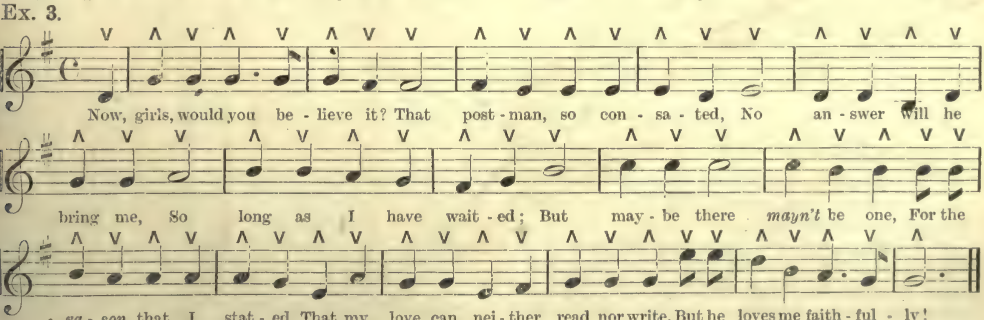


Ex. 2.



Music and Numbers. To become an accomplished violinist, the fingers of the player must learn, by diligent practice, to associate tones and numbers automatically. In this sense, fiddle music and mathematics are twin brothers. When the Greek philosopher, Pythagoras, based his series of sound ratios on numbers, he anticipated Corelli, the father of violin players, by twenty centuries. The easiest way of committing to memory the numerical fingering of G major, or any other scale, is to vary the order of the notes. Thus, if we take a simple melody of moderate compass in that key, we find at once a suitable exercise. For this purpose, the student should now try to play the refrain known as "Katie's Letter," to which we attach the words, so that the notes may be bowed with suitable expression [Ex. 3].

Ex. 3.



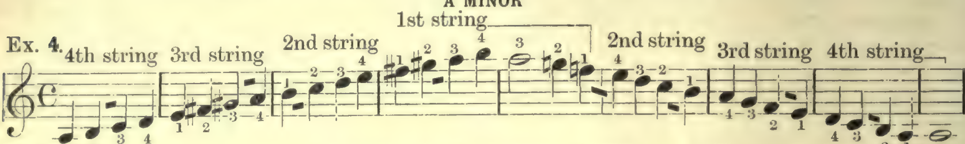
In A minor, instead of the semitones occurring between the third and fourth and seventh and eighth notes, as in the major scale, they now come between the second and third and seventh and eighth notes. The effect of this change gives a more plaintive character to the minor than the major modes.

The beginner will now note that, although the semitones are not the same in ascending as in descending a minor scale, the fingering is alike both up and down, the production of the right notes depending on the stopping being "humoured" by the fingers. Below C (the major scale which has no sharps in music) at an interval of a minor third comes the note A. [Exs. 4–8.]

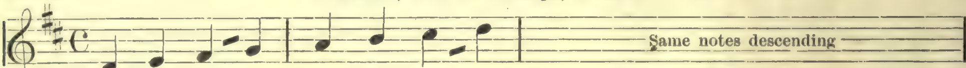
The pupil should now get pen and music paper. To impress on the mind the position of the semitones, it is well to copy out the scales; first, the tonic majors and relative minors, and then the tonic majors and tonic minors, the latter being those minor scales which begin on the same note but have a different signature of accidentals. Having written out the scales in all the sharp and flat major keys, confining the range to the compass of one octave, practise them carefully. To get variety, write the first and third scales in and beautiful. It is the thoughtless way in which scales are practised that makes them so distasteful. Think, therefore, of a great master playing a scale in an ideal manner. Try to imitate the dignity of his tone in bowing slowly. When, in course of time, the scale can be taken more quickly, the student should always have in imagination, if he wishes to improve his execution, the charm of the rush of brilliant sounds obtained by a clever virtuoso. The beginner's first attempts to play scales may be unhappy, but disappointment is the companion of all true happiness. The latter will come presently and be doubly appreciated if the pupil perseveres. Later on the scales may be extended to two or three octaves. "One thing at a time" should be the maxim of the beginner. If he succeeds in reading and fingering the notes of the different scales within the compass of an octave well in tune, slowly, he will have done

A MINOR

Ex. 4.

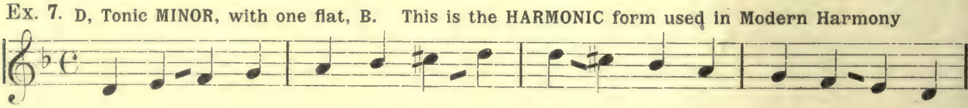


Ex. 5. D MAJOR, with two sharps, F and C



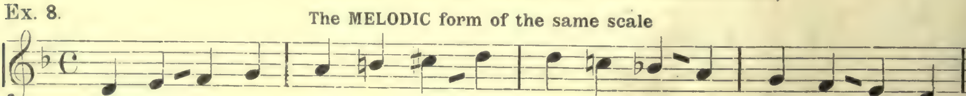
Ex. 6. B, Relative Melodic MINOR of D MAJOR, with same sharps

Ex. 7. D, Tonic MINOR, with one flat, B. This is the HARMONIC form used in Modern Harmony



(Observe altered situation of the half tone in third bar in Harmonic form)

Ex. 8. The MELODIC form of the same scale



(⁀ Half tones)

four-four time, the second and fourth in three-four rhythm, and so on.

Hymns. In order to impress the correct fingering on the memory, take the top line of some well-known hymn and transpose it into the different keys. Practise it slowly, and try to convey the meaning of the words to the sounds. As correct intonation is of great importance, the student should accustom himself to recognise, before beginning a piece of printed music, the key in which it is written. The "key" to the key is indicated by the last note of an unaccompanied melody, or the bottom bass note of the accompaniment. This is the general rule.

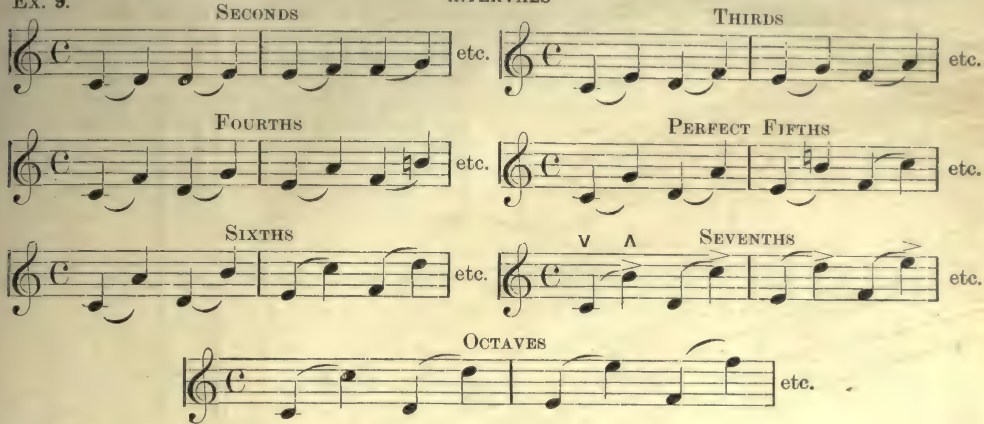
Scales. Many beginners have an unfortunate prejudice against practising scales. Although a badly played scale is decidedly uninteresting to listen to, yet under the bow of a Sarasate or an Ysaye there is nothing more brilliant admirably. Should the playing of scales become irksome, he has himself to blame for not concentrating his mind on their study.

Difficulties. It is attention to the things which are tiresome to the majority of people which makes for success, and even, in some cases, for genius. In this complex life of ours, the mind, if it be a good one, is strengthened by the difficulties it encounters. In the same way, scale playing strengthens the fingers. There is consequently considerable moral discipline in practising scales not once a fortnight, but regularly every day. The secret of success in singing, it may be whispered, lies in the ability of the vocalist to "scale" the voice beautifully. Of all instruments, the violin approaches most closely, in its methods of intonation, to the human voice. The practice of scales, therefore, is essential for proficiency.

If scale playing has been varied by the slow practice of chants, as suggested, the student will already have begun to make acquaintance with most of the *Intervals* [Ex. 9].

Begin each exercise slowly. Work up the speed gradually. Play each pair of notes with a full bow, down on the beginning of the bar, up on the second beat, and so on. Other methods of bowing will be dealt with later. Having studied the course on Transposition [page 1057], transpose the foregoing exercises into different keys. Next combine the intervals in the way suggested in Ex. 10.

Ex. 9. INTERVALS

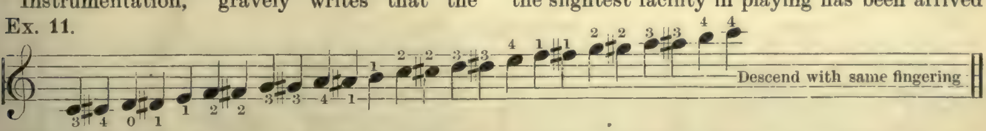


Ex. 10. COMBINED INTERVALS

Many sharps or flats may look formidable on paper, but the fingers of the violinist are not confronted, like those of the pianist, with black keys at a higher level than are the ivory notes. Therefore, accidentals should be easy to play on the violin, although Berlioz, in his clever "Instrumentation," gravely writes that the scales of E♭ and F are "difficult," that D♭ is "very difficult," and D♯ "almost impracticable." But Berlioz was a flageolet player rather than a fiddler, and Spohr, one of the greatest of violinists, carries more weight when he says that the violinist has an "equal command of all keys, even those the most remote."

The Chromatic Scale. This question of accidentals leads us to the artificial scale, known as the *Chromatic*, which proceeds entirely by half-tones [Ex. 11].

Ex. 11.



The student should remember that more than one note in this scale must never be stopped with the little finger, and that the same finger must never be employed thrice in succession. He should avoid also sounding the open E and A strings, whether in ascending or descending. The exact fingering depends a good deal on the character of the music. In moving the second or first finger up or down, be careful to go at once for the precise stopping-place. Lingering midway in the stopping spoils the intonation.

Let us repeat that, if proficiency is to be attained, the student must concentrate his attention on one exercise at a time. As soon as the slightest facility in playing has been arrived at, a desire arises to skip serious study and get on to "pieces." With a pupil who has a master to check him this tendency is bad; but the temptation requires double will-power to conquer when the pupil is working unaided. Instead of frittering away valuable leisure with meaningless tunes, the ambitious student will be

better employed acquiring facility in steadily bowing the *Broken Chords* in Ex 12.

Practise these slowly at first. After getting the intervals in tune, increase the speed. Transpose this exercise into all the other major keys.

Practice Table. At this stage the student should make out a practice table. Apportion the time which can be devoted daily to violin study somewhat as follows :

Scale of C major..	5 minutes
,, ,, A minor	5 ,,
Intervals	15 ,,
Broken chords	15 ,,
	—
	40 minutes

bridge, it diminishes the sound of the violin. In any case, the beginner desirous of cultivating a good tone should refrain from playing feebly at first. Not only should the bow, both up and down, be made to bite well without roughness throughout its length, but the fingers must stop the strings firmly. This effort may produce corns on the tips of the fingers of the left hand, but in a short time these will give no trouble.

End of Practice. After practice, slacken the hair of the bow. Before putting the violin away, rub off the rosin with a soft handkerchief, and wipe the stick of the bow. Should the fiddle require general cleaning, wipe it with weak whisky and warm water, and finally with a little light oil. When the bow gets greasy, wash

Ex. 12. BROKEN CHORDS

This plan can be changed discreetly day by day, but 40 minutes at first is long enough for the beginner who is in earnest. It is wise to practise in solitude. If the room cannot be otherwise reserved, rise an hour earlier than usual. In that case, to avoid annoying sleepers, a skeleton, or mute violin, can be bought for about 10s. But these so-called practice violins should be avoided wherever possible. They have a bad influence on the learner, and tend to destroy his conception of tone. A "mute" is better, and can be purchased for a few pence. Placed upon the

it with soap and tepid water. Conclude the bath with fresh and cold water. Dry the hair before a fire, then rub with fine powdered rosin.

As soon as the many difficulties which confront him begin to be perceived, the first eagerness of the violin student is apt to abate. It is easy then to neglect practice for a while. But such a procedure is fatal to progress, and it is only by resolutely adhering to the plan of study drawn up that the self-instructor will presently become a good player. The beginner must imitate the tortoise rather than the hare if he wishes to triumph.

Continued

HOW WE HEAR

The Function and Structure of our Ears. Their Amazing Power of Reconstructing Sounds. Analysis of Sound, and Some Experiments

Group 24
PHYSICS
16

Continued from page 2106

By Dr. C. W. SALEEBY

HAVING discussed the objective nature of sound, its speed, intensity, reflection, refraction and production, ending with its production by the oldest and most valuable of all instruments, which none of us needs to purchase, we may now turn to the consideration of the physical aspect of hearing. Let it be clearly understood that our business in this course is only with the physical aspect of a function which, of course, it is more properly the province of the physiologist to investigate. But we must carry the physical inquiry as far as possible, being quite certain of this, that the more complete it is, the more valuable will be the help that we are able to afford to the psychologist, who, after all, must build upon physics if he is to build securely. And by way of an introduction to the subject we may begin with a simple and easily dismissed question: How are we able to locate a source of sound?

The Direction of Sound. The use of the external ears in the lower animals is obvious to anyone who has observed them. It is evident that if these ears be inclined at different angles the animal will find a given sound louder when the ear is at one angle than when it is at another. He is thus immediately guided to the source of the sound. Even in man there persist three small muscles, attached to each of our external ears, the function of which—had they not lost it—is to move the ears in various directions. But, in point of fact, the large majority of people have completely lost the power of moving the ears at all, though some of them can move the ears in association with movements of the whole scalp, while a few retain the power in some small degree. But no one ever uses it for the purpose of estimating the direction of sound. In any case, the ear has so largely lost the shape which should make it valuable that the power would be of little value if we retained it. It has been shown that if the whole of the external ear be filled up with wax, leaving just a small hole corresponding in width to the canal that leads inwards to the middle ear, the acuteness of hearing is very slightly diminished—that is all.

Do our Ears Deceive us? Now, it may be argued that, in reality, we cannot judge the direction of sound, but are constantly deceived. The deception, however, is more apparent than real. We are deceived merely because the sound is reflected from some surface, and we locate the source of the sound in the direction of that surface. Nevertheless, our ears have served us quite faithfully in indicating the direction from which the sound immediately reached them.

The most careful experiments have been made, especially by Lord Rayleigh, in order to discover whether there is any factor whatever that determines our appreciation of the direction of sound except the one factor which we are about to discuss. It is found, however, that no other explanations of this power can be afforded.

Two Ears and Two Eyes. Our appreciation of the direction of sound entirely depends, then, on the fact that we have two ears. You hear a noise, and immediately turn to the left; the simple reason is that the sound is more loudly heard by the left ear—that is to say, by the right side of the brain—than by the right ear—that is to say, by the left side of the brain. Observe the curious fact that the hearing is really done most effectively, not in the part of the brain which is nearest the sound, but in the part which is furthest from it. The explanation obviously is that the brain appreciates not directly from the external world, but through the mediation of the organs of sense, and in the case we are considering it is the left ear that is most markedly stimulated. Various experiments—both those made for the purpose and the experiments of disease—go to prove that our internal comparison of the relative measure of stimulus received by the two ears is our means of determination.

The case is parallel to that of the eyes. In each instance the development of pairs of organs would appear to have been originally due to the same causes as have produced the double symmetrical arrangement elsewhere in the body. But whereas no extra value of any special kind is due to the fact that we have, for instance, one lung on each side of the body, the similar possession of two eyes means not merely that we are able to see things more intensely, but also that we are able to perceive their form in perspective by an unconscious comparison of the slightly differing images which the two eyes perceive; and, similarly, the possession of two ears enables us not merely to perceive sound more acutely, but also to perceive its direction. If a patient be completely deaf in one ear, he is compelled, of course, to use his whole head, just as a donkey uses its external ears, moving it as a whole until he chances to get the opening of the healthy ear opposite the source of sound, the position of which is thus identified.

A Simple Experiment. It is an obvious consequence that, if we produce sound in such a fashion that it is absolutely equidistant from the two ears, we shall be able to defeat any possibility of locating it, except in so far as the

subject of the experiment is able to say that the sound *is* somewhere equidistant from the two ears. In order to obtain success with the following experiment, it is necessary that the acuteness of hearing in the two ears be equal. The subject is blindfolded, and a noise is made by the finger and thumb, or any other means, just in front of his nose, under his chin, or at the back of his neck. From the fact that the sound is heard equally in the two ears, the subject will rightly confine his guesses to the plane in which these places lie, but as to the exact part of the plane from which the sound proceeds he will be completely nonplussed. A sound produced under his chin is as likely to be referred to the top of his head or to the back of his neck as to its actual source. This simple experiment affords a very conclusive proof of the accepted theory. From this simple problem we must pass to the actual mechanism by which we appreciate sound. Thereafter it will be well to note other means by which sound can be appreciated or its consequences made evident.

The Structure of the Ear. The sound wave which has been more or less collected by reflection in the external ear passes through a short canal, at the bottom of which is found the *tympanum*, or *drum* of the ear, which is thrown into vibration synchronous with—that is to say, at the same rate as—the alternation of compressions and rarefactions that constitute the sound wave. To the inner side of the drum is attached a small bone which is joined to another, and it to a third. These three *auditory ossicles* (ossicle meaning a small bone) form a very oblique bridge across a narrow air-filled cavity which, though really little more than a slit, is known as the middle ear. The air which it contains is supplied from the throat by means of a special channel which is known as the Eustachian tube. This permits the air to pass in or out, so that its pressure may always be the same as that of the air on the outer side of the drum—that is to say, that its pressure may be the same as whatever happens to be the atmospheric pressure at any given moment. The persistence of this equality of pressure is necessary not only for comfort, but also for successful hearing. If we descend to the bottom of a coal-mine, where the atmospheric pressure is raised, or if we ascend in a balloon, so that the atmospheric pressure is lowered, it is a wise precaution occasionally to swallow one's saliva, as this act opens the Eustachian tube and permits of the equalisation of pressure. If the tube be closed, as may happen in disease, the air within the middle ear is apt to be absorbed and the pressure thus lowered, with evil consequences.

The Middle Ear. The business of the three bones is to transmit the to-and-fro vibrations into which the first is thrown in virtue of its contact with the tympanum. Two minute muscles are attached to these bones, one of which, when it contracts, tends to tighten the drum of the ear so that it responds more readily to aerial vibrations of small amplitude. The hearing is thus made more acute, and we therefore employ this muscle when we strain to hear. When the second muscle contracts it tends to lessen the rigidity of this threefold conducting apparatus. It is therefore of value when we try to reduce the intensity of loud sounds. Sometimes it is paralysed, and then loud sounds are found to be very painful. This muscle is the nearest approach that we possess, since we have no earlids, to an apparatus for cutting off external vibrations—which our eyelids do so efficiently for the eyes.

The Inner Ear. The third and last of the three bones is fixed to another membrane which is thrown into vibrations corresponding to the vibrations aroused in the tympanum, and which closes a remarkable canal filled with fluid, the said canal being part of the internal ear, the essential part of the organ of hearing. The sound vibration, more or less modified in amplitude, perhaps, by the action of one of the muscles we have named, is communicated to the fluid of this canal, which takes a spiral shape that has some resemblance to the shell of a snail, though it is very much smaller. This canal lies in the hardest bone in the body—the hardness and rigidity of which are of value, in that they do not tend to damp sound vibrations which are appreciated within it. As the sound wave travels along this spiral canal, it naturally affects an extraordinary structure which lies along the whole length of a continuous bridge or partition that divides the canal into two. This structure is known as the organ of Corti.

The Piano Theory of Helmholtz. Since the canal steadily diminishes in width throughout its entire length, it follows that the fibres constituting the bridge become shorter and shorter. This fact aroused the careful attention of the illustrious German physicist, Von Helmholtz, whose name will go down to all time as one of the founders of the doctrine of the conservation of energy. Helmholtz supposed that, as in the case of a piano, the shorter fibres of this bridge—those that lie nearer the apex of the spiral—correspond to musical notes of higher pitch, while the longer correspond to the low notes. This may be described as the theory of sympathetic vibration, or, more briefly, the resonance or piano theory of hearing. This theory has been widely held, but it is extremely difficult to perfect it in accordance with the facts. It is, however, most remarkable that there have been recorded numerous cases of partial deafness, where the patient was able to hear every note on the piano, perhaps, except one, or a sequence of two or three. In such cases it has sometimes been found that there has been some destruction of the structure of the internal ear, more or less corresponding to what might have been expected on the assumption that the piano theory of Helmholtz is correct.

The Function of the Cells. At any rate, the fibres of this long bridge are covered by a company of tiny living cells, which are provided with minute sensitive hairs, and which must be regarded as the true auditory cells, corresponding to the distinctive visual cells of the retina of the eye, which are the immediate means of our appreciation of those

ethereal vibrations which we call *light*. The hairs of the auditory cells doubtless appreciate every motion or change of pressure which a sound wave from outside may impart to the fluid in which they are bathed. The base of each of these innumerable cells—the actual number being about 15,000—is directly supplied by a tiny branch of the nerve of hearing. But when we come to the transformation of material vibrations into nerve energy, we have reached the limit of what is ordinarily regarded as physical inquiry. The entire length of the canal we have described is about 1 in. As this is very much shorter than the shortest wave-lengths of any sound that we can appreciate, it follows that the whole internal ear must constitute one vibrating system, the whole of which at any one moment is in the same phase. The structure is infinitely more complicated than we have described, but perhaps the only one of its many details that need also be mentioned is the occurrence of a viscous substance which is always found at the base of the auditory cells, and which is supposed to have the function of preventing or damping after-vibrations.

How we Recognise Sounds. We may now turn to an aspect of our subject which would lead us, if we pursued it indefinitely, towards the subtle science of *æsthetics*, to which allusion was made when we began to study this subject. The question of the recognition of the pitch of a simple tone is difficult enough, as we have seen, but it is as nothing compared with the difficulties of understanding the means by which we recognise and appreciate compound tones—the means, for instance, by which the late Sir Charles Hallé was able, while conducting a full orchestra, to detect which violins were playing out of tune. Perhaps the best fashion of understanding the extraordinary difficulty of such a feat is to use the following analogy, which the present writer suggested some years ago.

Let us take the case of the movements of an electron constituting part of an atom of matter upon the surface of the moon. This electron is partaking of a very large number of motions—even begging the hitherto unanswered question whether it is in rotation on its own axis. We are sure, at any rate, that it is moving within the atom—probably revolving around the atomic centre. It also partakes in that movement of the atom as a whole which constitutes what we call heat. Together with the atom which it helps to compose, it must also be supposed to be drawn gradually towards the centre of the moon as she cools. It is also moving as the moon rotates upon her own axis, and as she revolves around the earth, and as the moon and the earth revolve around the sun. But astronomers tell us of the proper motion of the sun, and declare that the solar system as a whole is journeying at the rate of some 11 or 12 miles a second towards the bright star Vega in the constellation Lyra. Thus, there are seven or eight motions, and we know not how many more, which the electron is simultaneously performing. Upon these we may all be agreed, but at the same time we are also agreed that, at any given moment, the electron is moving in only one direction and at one speed. Its absolute motion is the consequence of the composition of all these relative motions.

"Hearing by Imagination." Now, the case of the electron is extraordinarily similar to that of the particles of air in a complex sound wave. The mind forbids us to conceive that any of the particles are moving in two directions at the same time. In order to do so we should have to think of them in two places at the same time. What, indeed, reaches the ear when we listen, for instance, to combined orchestra and soloists, is not the sound wave corresponding to the voice of any of the singers nor the sound wave corresponding to any of the instruments. It is a wave of incredible complexity, the form of which is determined by all the sources of sound involved.

Each of these sources of sound can do no more than modify the form of the resultant wave in proportion to the form and amplitude of the wave which it would produce if, so to speak, it had the air to itself. In fact, then, when the ear of a musician distinctly hears the phrase which the violins are playing or the tenor is singing at any given moment, he hears what is not there; the wave form corresponding to the violins or to the voice is represented merely by one phase of the complex movement which the ærial gases are performing. The ear is thus able to reconstruct, imaginatively, the rest of the wave from a mere fragment of it, and the listener thinks he hears the tenor's voice, whereas in reality he only hears a complex sound wave, the form of which has been somewhat modified by the fact that the tenor has contributed his own tendency to it.

A Wonderful Power of Reconstruction. Similarly, in a clamour of voices, the result of which is one single wave form, the ear is able, at choice, to listen to the whole as a clang or harmony, or to recognise from all these voices one that is familiar, or even to recognise in that familiar voice the particular relation of over-tones which may indicate any particular emotion, such as joy or fear. Yet, unless we are to accept the inconceivable proposition that the atoms of air can be in two places at once, we are compelled to recognise that the ear has reconstructed, from a mere indication, particular wave forms which have no actual existence. In the opinion of the present writer, this analytical or reconstructive power of the ear is the most remarkable of all our sensory powers, and is seen to be none the less so when one examines the complex wave forms which the modern phonograph is able to record.

There is no analogy in the case of sight, which, indeed, is inferior to hearing in discrimination. Wherever one turns one's eyes, any given portion of the retina, or perceiving curtain, at the back of the eye merely appreciates the particular ether waves that happen to fall upon it. Even if one fixes attention on a particular part of the field of vision—a particular feature of the landscape or the freckle on the side of the nose

of the person you are speaking to—there is no reconstructive or analytic power such as the ear possesses.

The Ear's Analysis of Wave Sounds. A complex wave form consists of a number of ripples of varying size and shape, moulded upon bigger wavelets, which, in their turn, are moulded upon waves bigger still. Each of the little ripples simply indicates all that is left of the wave produced by—say, at a choral-orchestral concert—a given horn or violin or contralto when that wave has been merged in and blended with all the other waves that are coming from the stage. Yet from a mere hint, such as an amputated curve in the whole complex vibration, the hearing ear can reconstruct and imagine that it hears the voice of any of the soloists or the tone of any of the instruments in the orchestra. The case is even more remarkable, indeed, than, for instance, the reconstruction of an extinct animal by study of one of its bones; for in the case we are considering there is really left not even an amputated portion of the sound wave belonging to any of the instruments or voices. It is impossible to point to any part of the wave form and say "the flute contributed that." If the diagram of the wave form of the flute were superposed upon the diagram of the complex wave form that is actually produced, there would be no coincidence between them at all. These considerations make this amazing power of the human ear more amazing still.

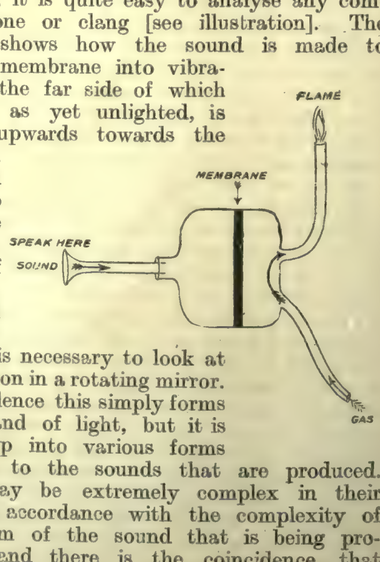
Sound can be Felt. If we realise that sound has an objective basis consisting of material vibrations, it will be plain that, as we noted above, there are other means than the living ear by which sounds may be appreciated. They can, of course, be appreciated by the finger—that is to say, the finger can feel the vibrations of a vibrating object. There is a profound difference between the impression which such an object makes on the sense of touch and that which it makes on the sense of hearing. But the objective fact, whether we call it sound or whatever we please to call it, is one and the same. Similarly, when a doctor asks the patient to say "ninety-nine," he may place his hand on the chest and feel the vibration, or may put his ear to the chest and hear it.

The phonograph offers a simple illustration of the means by which sound vibrations may be felt, so to speak, and recorded. Its essential part consists of a drum, which corresponds to the drum of the human ear and to which there is attached a needle; just as if one removed the tympanum and the little bone which is attached to it. The end of the needle makes marks upon tinfoil or wax which is made to pass underneath it. The shape of these marks and their depth correspond to the form of the sound wave which agitates the drum. If, now, the arrangement be reversed, the tinfoil or wax moves a needle placed upon it, affects the drum, and so reproduces exactly similar sound waves to those which made the original impression. It will be obvious to the reader that there is an analogy between the phonograph and the camera.

Professor Tyndall's Sound Flame. We have already, when discussing sympathetic vibration, made reference to the experiments of Helmholtz in the tuning of resonators, and it was noted that the resonators may be so arranged in a series as to affect flames placed opposite them. There is no real distinction between this action and the action of blowing at a flame and making it flutter. Many experiments have been made with flames especially designed so as to be very sensitive to sound, the most celebrated of these being the so-called vowel flame contrived by Professor Tyndall. This is about two feet high, and is extremely sensitive to all sorts of sounds and musical notes. It responds especially to tone of high pitch, and therefore to those particular vowels which contain the largest number of over-tones of high pitch. For instance, it is very much more markedly affected by the vowel ee than by the vowel oo. For we may here note that, as Helmholtz proved, the difference between the various vowel tones—every one of which may be sung on one and the same note—depends upon the variation in their over-tones. It appears that in the case of vowel production the over-tones are produced partly in the mouth itself. It would seem to be a conclusive proof of this fact that we are able to whisper the vowels.

When a noise or musical note is made to which the flame responds, it will quiver in greater or less degree, or may actually be so much shortened as almost to disappear. The instant that the noise to which it objects ceases, it jumps up again.

Analysis of Vowel Sounds. The German physicist König has utilised these facts in order to make what he calls a *manometric flame*. If we take a series of Helmholtz's resonators and attach them to the manometric flame apparatus of König, it is quite easy to analyse any compound tone or clang [see illustration]. The diagram shows how the sound is made to throw a membrane into vibration, on the far side of which the gas, as yet unlighted, is passing upwards towards the flame. Now, in order to observe the movements of the flame, which are very rapid, it is necessary to look at its reflection in a rotating mirror. During silence this simply forms a long band of light, but it is broken up into various forms according to the sounds that are produced. These may be extremely complex in their shape in accordance with the complexity of wave form of the sound that is being produced; and there is the coincidence that might be expected between the form which the altered flame takes in the mirror and the



form of the marks produced by the needle of a phonograph under the influence of the same sound.

Now, it is especially by this admirable combination of the devices of Helmholtz and König that it is possible to analyse completely the nature of the various vowel tones. But even this method has lately been superseded, or, at any rate, supplemented, by the application of photography to the phonograph, and the subjection of the curves so obtained to mathematical analysis. The consonants, by the way, are mere noises.

Harmony and Discord. Finally, we may note a few of the simpler facts of harmony and discord; and, in the first place, we must observe the peculiar phenomenon called *interference*, of which much more must be said when we come to consider waves of light. Interference is a phenomenon common to all forms of wave motion, and everyone has observed some consequence of it who has watched the rebounding of waves from a breakwater. Everyone knows how, when the two crests, the one of the advancing and the other of the rebounding wave, coincide, the water is very much raised The case is similar if two stones are thrown side by side into a pond. On the other hand, where crest and trough meet one another, they neutralise one another. This is why the phenomenon is called *interference*.

The musician knows interference because of his familiarity with what he calls *beats*. When two notes—as, for instance, two low notes on the organ—are sounded together, we get an unpleasant effect of sudden reinforcements of the sound called beats. In such cases we always find that the two notes are really very near one another—perhaps nearer one another than any two notes on an organ in tune can possibly be. These beats or throbs constitute the ultimate basis of discord. Now, discord is usually taken as synonymous with disagreeableness of sound, but the question of pleasantness or otherwise of sound is a matter of taste, and therefore not open to dispute. It all depends on the number of beats which the individual ear can tolerate. Not only so, the occurrence of discords is of immeasurable musical value. As Browning says, "Why rushed the discords in but that harmony should be prized?"

"Out of Tune." One interesting fact remains to be noted. We have strongly insisted upon the constant and necessary character of the simple relation between the various notes of the scale. It was observed that the most beautiful note might be produced during the playing of any piece of music, but that if such a note were not actually in the scale—in other words, if it were what is called "out of tune"—it could have absolutely no musical value. These simple mathematical ratios are fundamental to music, but, in the case of an instrument such as the piano, it can easily be shown that, if we are to insist upon this, it will really be impossible to construct a piano at all; or, at any rate, it would be possible only to construct a piano that was in tune for one key—obviously a piano on which it would be possible to play only the simplest tunes. If the ratios for the key of C are exactly those which we have quoted, then it is impossible to obtain the same ratios for the key of D. Hence, there is adopted the device which is known as *equal temperament*, which effects a compromise between all the possible keys, so that, in whatever key we are playing, the ratios of its notes are equally near to—and far from—the perfect ratio. The ordinary ear cannot perceive the small departure from true intonation. Such a difficulty does not occur in the stringed instruments, where the player makes his notes as he goes along. One of the delights of the Joachim Quartet—playing by themselves—is that the players play absolutely in tune. If they play a quintet with a piano, the difference can be observed by good ears.

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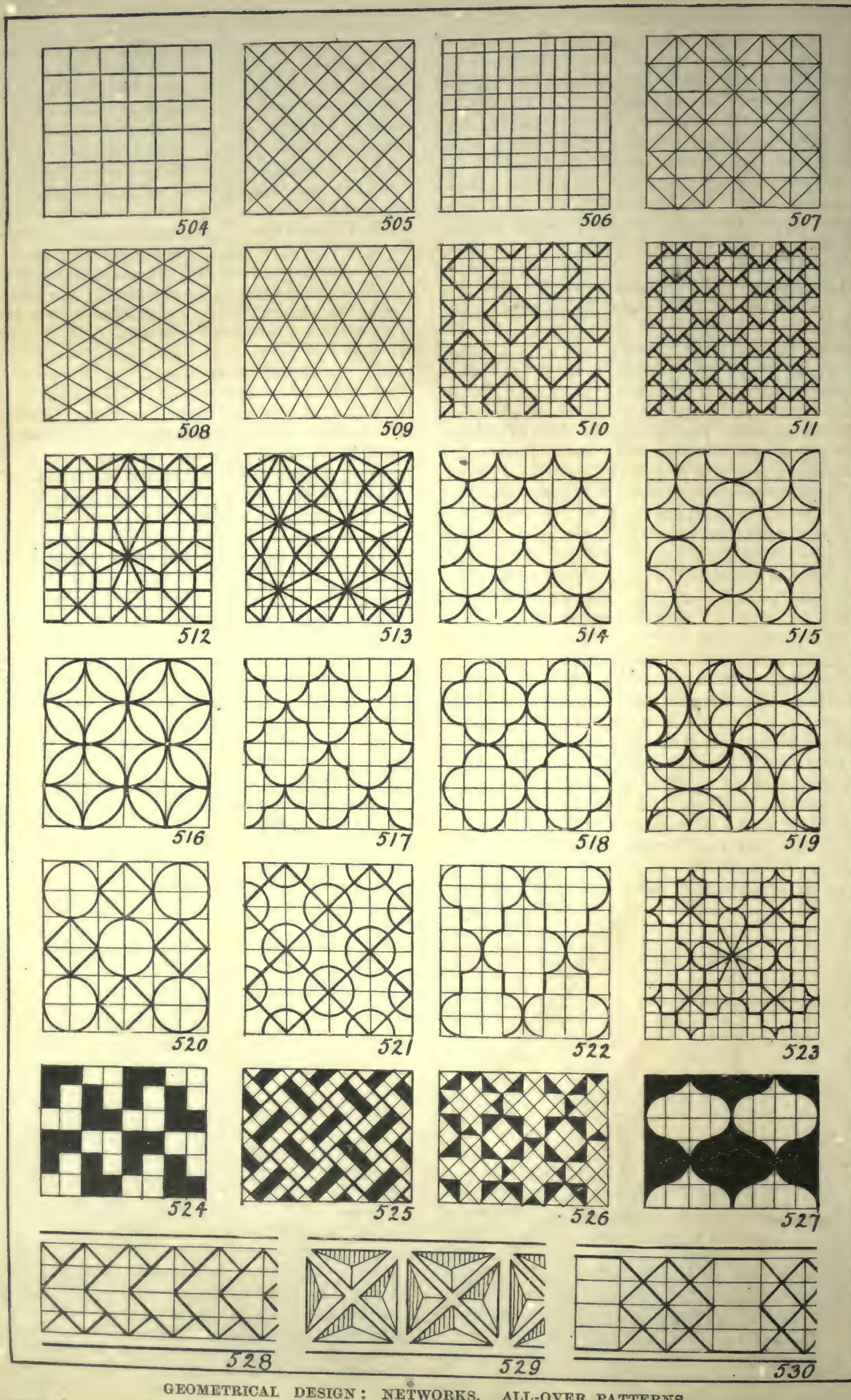


GEOMETRICAL DESIGN: NETWORKS. ALL-OVER PATTERNS

GEOMETRICAL DESIGN

Its Origin and Application. Groups. Explanation of Terms. Networks. All-over Patterns. Borders

Continued from page 2188

By **WILLIAM R. COPE**

Primitive Design or Ornament. Although geometrical ornament is more abstract than that founded on natural forms, yet it is the oldest, as is shown by the primitive art of savage races of past and present times. No doubt this is so because geometrical ornament is easier, and requires less artistic skill than conventional arrangements of natural forms. Probably sewing with a thread suggested the zigzag line, the wave that of the wavy line, the woven work led to reticulated patterns, the plaited hair to that of the plaited band. The revolution of a fork gave the circle, the combination of dots at regular intervals suggested the polygons or pointed stars. The gradual development of these original geometrical forms, due to the growth of culture and knowledge, led finally to such geometrical artistic forms as are seen in Moorish panelled ceilings, in Gothic tracery, in the guilloche pattern, etc.

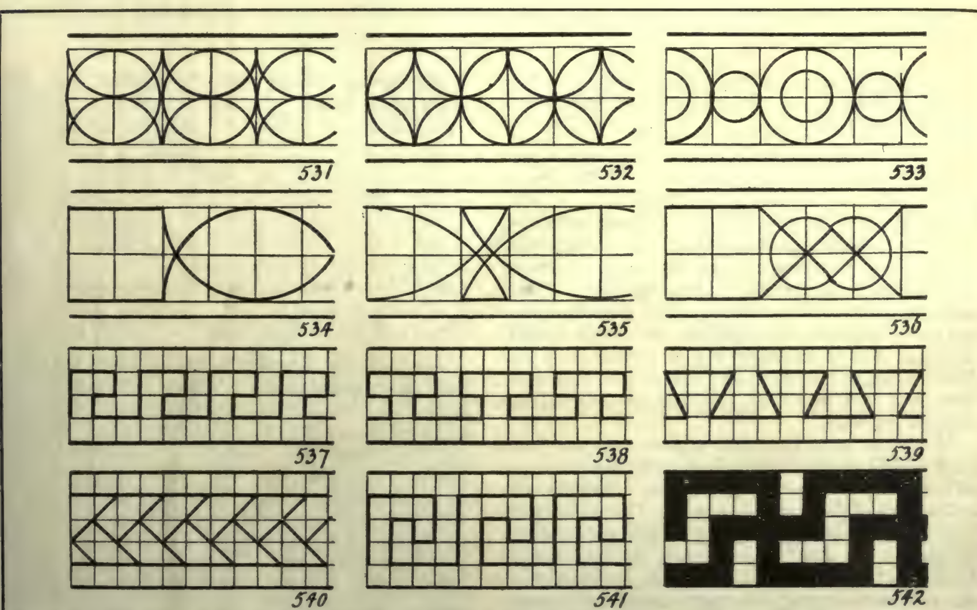
Application of Geometrical Design. The laws of geometry appear to have controlled the beautiful artistic designs of the ancient Greeks, and the decline of art in the different ages can be traced to neglect. Few workers seem to realise how universal are the applications of geometry to artistic ornament, such as is used in architecture, wall decoration, mosaics, parquetry and marquetry, tiles, floorcloths, carpets, pottery, metal-work and jewellery.

Groups of Geometrical Ornament. Geometrical ornament may be generally divided into three groups: First, when the ornament is in bands or borders, as in **528** to **560**; secondly, when it is repeated in patterns over an unlimited space, as in diapers [**510** to **527**]; and thirdly, when the ornament fills an enclosed space, as in panels of various shapes.

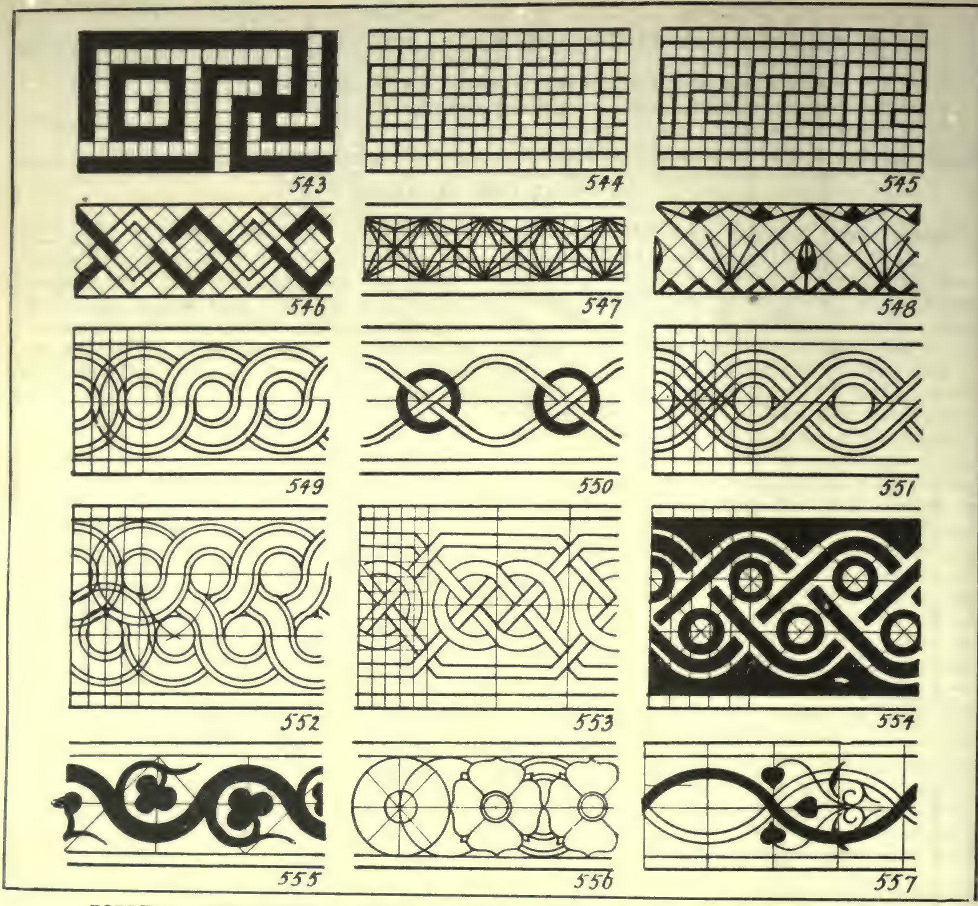
The designs here given are not by any means exhaustive, but are suggestive of the many variations that can be made in geometrical forms. The student, after copying them as exercises, should endeavour to design suitable variations in order to develop his ingenuity and taste.

Explanation of Terms Used. *Repetition* is a succession of the same form. This becomes monotonous if not varied, and for this reason the curves are introduced among the interlacing straight lines in **553**. In **547** the nailhead shape is *repeated*. When the same shape is repeated in an opposite direction, it is said to be *reversed* or *contrasted*, as in **527**, where the left-hand half of the repeat is reversed in the right-hand half of the same repeat.

Symmetry is the repetition of any form on its axis, as in **527**, where the central vertical



BORDERS: INTERLACED PATTERNS, GREEK FRETS



BORDERS: GREEK FRETS, CHAIN, NAILHEAD, GUILLOCHE, AND OTHER PATTERNS

line in each repeat is the axis. This principle of symmetry is one of the most important for producing ornament.

The *unit of design*, or *unit of repetition*, is the whole ornament in each repeat, as in **547**, where each nailhead is the unit of design.

Kinds of Network. The construction lines used in setting out geometrical patterns are arranged to form a *network* in order to secure accuracy of construction and repetition. This network is of various kinds. The most frequent are quadrangular reticulation, as in **504** to **507**, in which **505** is the *diamond* or *lozenge* net, and **507** is a combination of the square and diamond, while **508** and **509** illustrate the equilateral triangular network.

It will be seen that the square net has been used in **510** to **524**, and **527** to **545**, the diamond in **525**, **526**, **546** and **548**, and the triangular net in **561** to **574** [see next lesson]. These different nets may be easily and accurately constructed by means of the T-square and set squares of 45 deg and 60 deg. It is of course essential that the network should be very accurately made, otherwise patterns, especially those containing circular forms, will not repeat and fit properly.

All-over Patterns Founded on the Square Net. In **510** to **527** are shown examples of "*all-over*" patterns, as they are sometimes called. The designs in **510** to **523** would be suitable for window glazing, without further enrichment. They are also construction lines for richer patterns for carpets, tapestry, ceilings, etc. Figs. **524** to **526** suggest arrangements for parquet flooring. It will be noticed that **511** and **514** are similar to tiling arrangements for roofs, and are "*scale*" designs. In **527** the black and white forms are the "*ogee*" pattern.

Bands or Borders with the Square Net Foundations. These are not limited with regard to length, and are generally narrow, ribbon-like ornament. The principal patterns in this group are: The Fret, as in **537** to **545**: Chain, as in **546** and **550**; Interlaced patterns, as in **531**, **536**, **550**, and **553**; the Guilloche, as in **549**, **551**, **552**, and **554**; and Foliated Bands in the forms of Rosette [**556**], Flower, Leaf, Scroll [**555** and **557**], etc. There are also the Greek Wave scroll, the Leaf, and the Egg and Tongue pattern, which will be illustrated later.

Continued

ROAD DRAINING & LAYING

Draining the Road. The Dumb Well. Various Types of Gullies and their Uses. The Steam Roller. Channelling and Kerbing

continued from page 2183

By A. TAYLOR ALLEN

Draining the Road. Suburban and country roadways are often rendered impassable after heavy rains from the want of proper drainage. Deep ruts are formed, which become channels for the water, and there is no escape for the rainfall. One of the simplest modes of draining a country road in localities where gravel or stone may be had is to lay horizontal drain-pipes below the gravel, so that the rain will pass through to them. A good-sized pipe-tile is laid at the bottom, surrounded by small stones. On this coarse gravel or loose stones, such as quarry chippings, are laid, and above this a layer of fine gravel, then the surface gravel.

Such a drain in the centre of the roadway will often be sufficient, but for wider roads two lines of drains may be made. At all the depressions in the road, outlets must be made for the discharge of the water from the drain tile to the roadside, or natural channels, which cross the line of road. A properly compacted foundation, laid to a good inclination or section, and a well-metalled roadway and footpaths, throw off the water uniformly, and require only a few well-placed gullies to carry off the surplus rainfall.

Importance of Road Draining. Too much attention cannot be paid to the drainage of roads. When footpaths are constructed, a channel or watercourse is formed to receive the water which results from curving the transverse section of the road, and gullies are placed to about every 40 lineal yards of sewer, and at every intersection of streets, to convey the water through 6-in. pipes into a properly constructed sewer having a suitable outfall. In country roads, where there is no footpath or sewer, water tables (the width of a roadman's spade) should be cut obliquely at intervals to convey the water from the channel at the side of a road into a ditch or watercourse, thus carrying the water off before it can filter through the surface of the road.

The Dumb Well. When there are no natural outlets for the water, such as ditches, ponds, and watercourses, a *dumb well* is constructed under the path. This kind of well is dug and steined on the underpinning principle. The excavation is carried down as far as it can safely be taken without steining. An elm curb, made in two or more thicknesses, lap-jointed and cut circular, is then laid at the bottom, and the brickwork is built thereon. The excavation is then continued inside the curb. The earth supporting the curb is then cut out, with the exception of a few piers, a firm footing of timber is made in the centre of the bottom, and raking struts are put in to carry the curb; after which the piers are cut away, a new curb is put in, and the brickwork is carried up and pinned in under the old curb, which is left in position. In practice workmen often use more rough-and-ready methods, at considerable risk.

The well is then either domed right over in brickwork, or partly domed over, leaving an opening of about 2 ft. square for cleaning purposes, this opening being covered with a 3-in. York stone.

Road Drainage with Pumped Sewage. In a town or district where all sewage has to be pumped, it is of great advantage to keep the volume as low and as constant as possible; it would therefore be better to have a separate system for surface water. To give an idea of the enormous saving which would be effected in a district of this kind if the whole of a rainfall of 1 in. per hour were kept out of the foul sewers, and a 1 h.p. pump sufficed to lift the volume, it would require a 60 h.p. engine and pump to lift this large quantity of rainfall if the whole found its way to the foul sewers.

The table below is given, as rainfall plays a very important part in the designing and construction of storm and surface-water sewers.

The annual rainfall in England varies from 20 in. to 70 in., the average being 40 in.

The greatest rainfall in England in 24 hours = 3 in.

The greatest rainfall in England in one hour = 1 in.—in rare cases $1\frac{1}{4}$ in. and $1\frac{1}{2}$ in.

$\frac{1}{8}$ in.	of rainfall	= ·585	gal.	per yd.	superficial
$\frac{3}{16}$ in.	,,	= ·878	,,	,,	,,
$\frac{1}{4}$ in.	,,	= 1·171	,,	,,	,,
$\frac{5}{16}$ in.	,,	= 1·463	,,	,,	,,
$\frac{3}{8}$ in.	,,	= 1·756	,,	,,	,,
$\frac{7}{16}$ in.	,,	= 2·049	,,	,,	,,
$\frac{1}{2}$ in.	,,	= 2·343	,,	,,	,,
$\frac{9}{16}$ in.	,,	= 2·635	,,	,,	,,
$\frac{5}{8}$ in.	,,	= 2·928	,,	,,	,,
$\frac{11}{16}$ in.	,,	= 3·220	,,	,,	,,
$\frac{3}{4}$ in.	,,	= 3·514	,,	,,	,,
$\frac{13}{16}$ in.	,,	= 3·806	,,	,,	,,
$\frac{7}{8}$ in.	,,	= 4·099	,,	,,	,,
$\frac{15}{16}$ in.	,,	= 4·395	,,	,,	,,
1 in.	,,	= 4·687	,,	,,	,,

The following is a digest of the clauses for the preparation of a specification for this class of work:

Each length of sewer shall be laid in a perfectly straight line both in the horizontal and vertical planes, the levels and gradients shown upon the drawings being rigidly adhered to unless otherwise ordered in writing; and every pipe shall be accurately boned in with a proper boning-rod arranged between two fixed sight-rails.

The lateral position of the pipes or concrete tubes must be kept true by means of a cord or wire stretched in the trench close to the proposed position of the pipes.

The pipes, concrete, and brickwork shall be laid upon an even and solid foundation.

On the completion of each length of pipe-laying or other work, after the same has been examined and approved by the engineer, the excavations are to be at once filled in over and around the work, and the ground is to be made up to the required level.

In closing up all trenches selected earth or sand free from stones, lumps, or other hard substances more than two inches in diameter, shall be carefully shovelled into the trench to a depth of 1 ft. above the crown of the sewer. This material shall be solidly rammed down on both sides of the pipes so as not to disturb them. In the case of stoneware pipe sewers in trenches over 6 ft. deep, the earth shall not be thrown direct on the pipe, but shall first be shovelled on to a portion already covered and then passed along on the uncovered portion by a labourer in the trench.

All timber used for shoring or other purposes shall be carefully drawn as the work of filling-in progresses, and never in such a way as to allow the side of trenches to cave in or slide.

The trenches shall thereafter be filled up in layers of 9 in. deep, each layer being well rammed down over the whole surface before the next layer is filled in.

Walking over sewers shall not be allowed until they have been covered with at least 1 ft. of earth. All boulders, rocks, stones, logs, and other objects of over half cwt., and such other materials as the engineer may deem unsuited for filling, shall be considered as waste material.

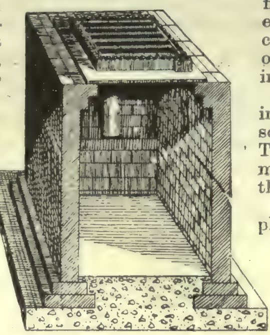
The contractor is to consolidate the ground filled in with a copious supply of water.

The joints of all pipes shall be well and truly made with Portland cement. The cement mortar used for this purpose to be in the proportion of one of washed sand to two of Portland cement, with a fillet of the same worked round the outside, the joints having been previously filled in with gaskin dipped in tar, rammed in so as to fill the extreme end of the space between the socket and the pipe for a depth of at least ¾ in. all round.

A proper tool with circular blade and long handle shall be used to take off and clean out the superfluous cement from the inside of the pipes.

All brickwork of manholes shall be executed in the most workmanlike manner; each course flushed in, grouted, and finished solid; the courses run parallel, or, where curved, evenly and uniformly to the curvature of the work, and centres in neat, close, and regular joints struck neatly and flush with the face of the work. In the case of work built on centres the joints shall be carefully cleaned off and finished upon the removal of the centres.

The manholes shall be constructed with square chambers. The foundations and floors shall be formed in cement concrete, properly shaped to the forms shown on the drawing. The floors of the manholes shall be rendered 1 in. thick in cement mortar, the whole being carefully constructed to the exact forms and gradients shown on the drawings. Semi-circular channels shall be formed in the concrete floors, and where two or more sewers enter a manhole the channels shall be curved so as to lead the sewage from one sewer into another with as little interruption to the flow as possible.



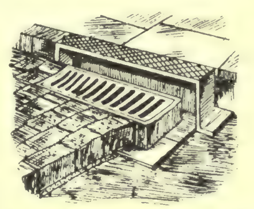
3. BRICK GULLY TANK

The walls and arches shall be built in brickwork and backed up behind solid with filling of approved material. The bricks shall be carefully cut and made good where the sewer pipes pass through.

Every manhole shall have cast-iron plates inserted in the arches where they are cut away to form the entrance to the manholes.

The covers shall be of the patterns shown and described, and they shall be carefully set to the slope of the ground surface.

Foot-irons shall be inserted and fixed in every fourth course of the wall, extending through the brickwork, and turned up so that they cannot be drawn.

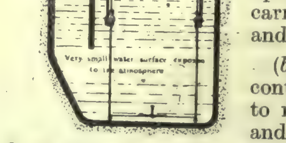


4. GULLY, SHOWING KERB OVERFLOW

Gullies. For roads and streets where *paved* channels are formed, iron or stoneware gullies, covered with iron gratings and frames, are used. A great number of different descriptions and types of gullies are on the market, and it is impossible to go into the merits of all, but they should be of such form, materials, and dimensions as the necessities of the case require.

For country roads and by-roads, where cost is a consideration, a suitable brick tank [3] can be constructed to hold a considerable quantity of the silt or detritus, which is carried down by every rain off such roads.

5. KNOWLE'S STREET GULLY



6. DURRANT'S PATENT STREET GULLY

The form and size can be decided upon only by the necessities and requirements of each case. The principal objects to be considered are:

(*a*) Sufficient area of open grating surface to carry off heavy rains and storm water.

(*b*) Sufficient cubical contents of the gully to retain road detritus and silt below the outlet, to prevent their being carried by the water into the sewer.

(*c*) A good water-seal or trap to prevent the escape of sewer gas.

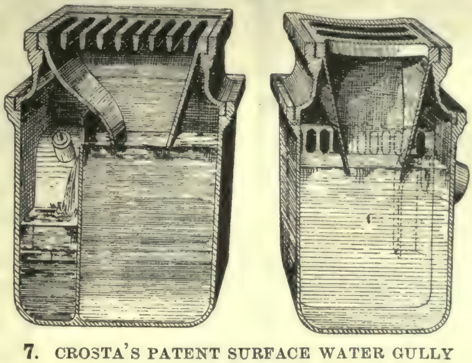
The gully tanks should be carefully bedded and fixed in their position, and the connection to the drain-pipes made with a cement joint.

The weir, or kerb overflow [4], is to be fixed

at such a height as to bone into the kerb height, and also of the channelling, so that the water may flow freely over the weir. The cover should be bedded on brickwork set in cement, and the top should be laid flush with the pavement.

Figs. 5, 6, and 7 illustrate certain types of gullies, and show their method of fixing. Figs. 8 and 9 illustrate gully gratings for brick and stoneware tanks.

Subways for Pipes. Although subways for underground pipes originated in the City of London about the year 1860, during the time the Holborn Valley and other improvements were effected, very little progress has been made in the development of the system.



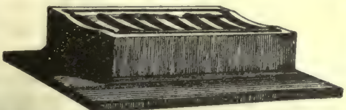
7. CROSTA'S PATENT SURFACE WATER GULLY

London subways, it is true, are the most complete of their kind in England, and are in size 16 ft. wide by 7 ft. 6 in. high, 12 ft. by 7 ft. 6 in., and 8 ft. by 7 ft. Nottingham has some most convenient subways, but nothing of the kind is to be found in Manchester, Liverpool, Birmingham, and other great centres, though, about 1895, the city engineer of Manchester prepared a scheme for subways under a section of new streets in that city at an estimated cost of £51,000 per mile.

Provincial Subways. In one of the principal subways in Nottingham the following pipes and cables are accommodated: One 15-in. sewer, two gas mains about 8 in. diameter, two water mains about 4 in. diameter, telephone cables, telegraph cables, and twenty electric cables.

To show the value of such works, in Victoria Street, Nottingham, in which is situated the General Post Office, there are, besides the gas and water pipes and connections, not less than six pipes containing telegraph wires in this subway, and not one single stone was disturbed or the carriage-way broken up for twenty-five years, and in that period not one single penny was spent on repairs in that street.

Visitors to St. Helens can hardly escape the conviction that there is one other borough in which experimental undertakings of subways are ventured upon.



8. GULLY GRATING

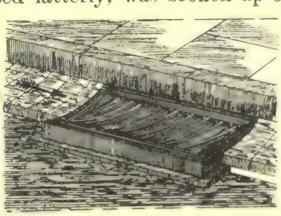
It is, in fact, an agreeable surprise to find a comparatively small provincial town actually and successfully leading the way in an experiment which but a few years ago was often regarded with ridicule.

Construction and Cost. These subways are constructed wholly of concrete, with the exception of a $4\frac{1}{2}$ in. ring of the brick to form the arch, and are 6 ft. 6 in. high by 5 ft. 6 in. wide, and contain one 18 in. gas main, one 10 in., and one 6 in. water main, with provision for telephone and electric light cables. The cost of these subways was £7 2s. 4d. per lineal yard, this amount including all the lateral ways and the electric lighting throughout.

In 1901, beneath the City of London streets, there were 2,540 lineal yards of subways under the control of the City Corporation, in addition to $1\frac{1}{2}$ miles not controlled by that authority. The length of gas, water, and hydraulic mains, telegraph and other tubes laid in the corporate subway amounted to nearly nine miles. The electric light and telegraph conduits alone contain some hundreds of miles of wires and cables.

Value of Subways. All engineers to municipal authorities are agreed upon the theoretical desirability of constructing underground subways for the reception of all sewers, gas, water, and electric mains, telephone and other wires, so that the operation of the local authorities, gas, water, telegraph, electric lighting and other companies, in laying down, renewing, maintaining, repairing, testing and inspection of their mains, pipes, cables, wires, and services may be facilitated and the existing inconvenience arising from the opening of the roads obviated.

Steam Rolling. The invention of steam rollers, so far as any practical results were obtained, was effected by Mr. William Clark, the City Engineer of Calcutta, and the late Mr. Fothergill Batho, of Westminster, who took out a joint patent for a steam roller in 1865. The first constructed rollers were generally 15 tons in weight, although one of 30 tons was built for the Liverpool Corporation, and, although not used latterly, was broken up only in 1890.



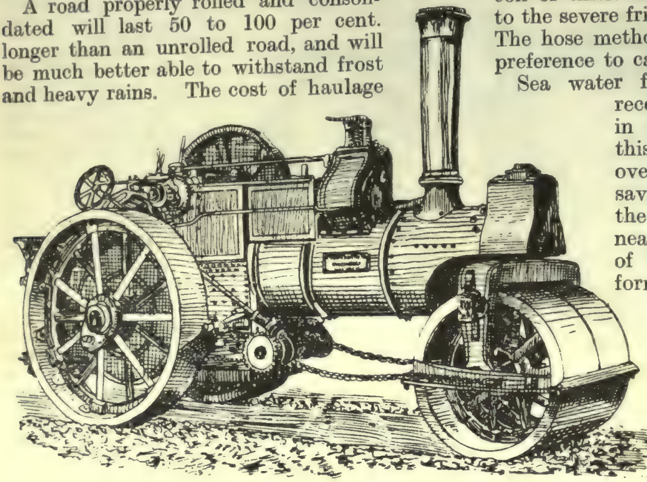
9. GULLY GRATING

In 1865 a trial was made in Hyde Park by Messrs. Aveling and Porter in steam rolling. An ordinary traction-engine had its wheels exchanged for heavy and wide roller wheels. The trial was considered a success, and the next improvement was the roller supplied by this firm in 1867 to Liverpool [11]. A modern roller is illustrated by 10.

Capacity of the Steam Roller. By the use of steam rollers some 2,000 superficial yards per day can be efficiently rolled at a total cost of one-third of a penny to one-fifth of a

penny per sq. yd. By the use of the roller the road is made at once; the stones which compose it, while still sharp, are driven at once into their places, to the infinite comfort of the horses and men who have to traverse it.

A road properly rolled and consolidated will last 50 to 100 per cent. longer than an unrolled road, and will be much better able to withstand frost and heavy rains. The cost of haulage



10. MODERN STEAM ROAD ROLLER

over its surface will be lower, and the amount of road detritus removed from it will be less.

Specification. The Local Government Board sanctions loans to urban and rural district councils for the purchase of rollers, spreading the payment over 10 years.

The following is a digest clause for a specification for steam rolling a new roadway when the work is done by contract:

The contractor shall include in his prices for a 10-ton steam roller attendants, sweepers, and water for well watering, rolling, and re-rolling the roads throughout after applying each coat, beginning with the chalk or hard core, which must be thoroughly consolidated, and all slack spaces filled in with the same material and rolled before the next coat is applied.

The finished coating to be well rolled in and consolidated, a sufficient quantity of binding material being used for binding; the whole to be well watered, steam rolled, and finished to a true and even surface, new flints being from time to time added to adjust any irregular places.

The road surface to be left smooth, firm, and compact, and to the contour as shown on sections.

Watering. Roads are sprinkled with water during the dry season for the purpose of supplying moisture to the surface, essential to ensure the best wearing results of macadamised roads.

The water is usually distributed by water-carts, a two-wheel cart holding from 220 to 300 gallons, and a four wheel van 400 to 450 gallons, the carts being filled from street hydrants [12].

In Paris, and a few towns in this country, watering is frequently done by hose attached to the fire hydrants in the street. Metal pipes with flexible joints are generally adopted, or, if hose-pipe is used, it should be protected by a coil of thick wire. Ordinary hose-pipe, owing to the severe friction it receives, soon wears out. The hose method is not to be recommended in preference to carts.

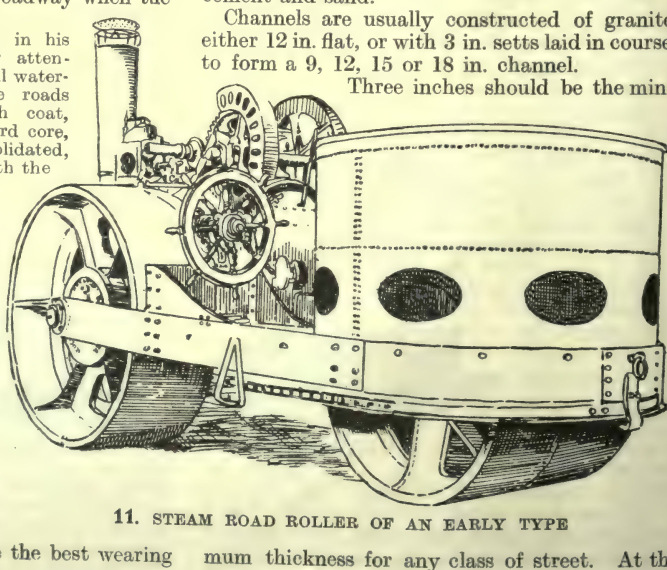
Sea water for road watering has during recent years been largely employed in seaside towns. Salt water for this purpose has some advantages over fresh. There is a considerable saving in the cost of sprinkling by the use of salt water when it is near at hand as compared with that of fresh; one sprinkling of the former will lay the dust for a length of time that would almost require two or three sprinklings of the latter. A road, after being sprinkled once or twice with sea water, will remain free from dust for some time after the road is practically dry, as the deliquescent salts contained in the water form a hard crust, which in a measure preserves the surface.

Channelling and Kerbing. Channelling, also known under the technical term of *gutter and water tables*, are essential for all roads to carry away the water.

All channels should be from 12 to 18 in. wide, and laid on a 4 in. concrete foundation, and well grouted in with liquid Portland cement or cement and sand.

Channels are usually constructed of granite, either 12 in. flat, or with 3 in. setts laid in courses to form a 9, 12, 15 or 18 in. channel.

Three inches should be the minimum thickness for any class of street. At the crossings or intersections of streets it is advisable to keep the channel level with the kerb, to enable pedestrians to step off the path on to the crossing without a drop; this can be readily done by using granite pitchers around the corner,



11. STEAM ROAD ROLLER OF AN EARLY TYPE

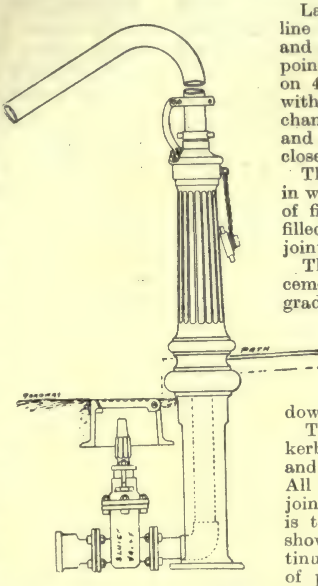
and allowing one edge of the pitchers to butt against the kerb, the other edge of the pitchers tilting towards the crossing, as it is very seldom that water has to be carried at these points.

Materials Used. The chief granites used are Aberdeen, Guernsey and Norwegian, costing 2s. to 2s. 4d. per lineal foot, 4 in. in thickness, 12 in. wide on a concrete foundation, and stones —Keinton, Purbeck and Shamrock—of the same dimensions, costing 1s. 6d. to 1s. 10d.

All footpaths should have a kerb on the outer edge to act as a sill for raising the path above the water flowing along the channel, and to retain the foundation and surface of the path.

The most usual kerb is a dressed granite, such as an Aberdeen, Guernsey or Norwegian, 12 in. wide by 6 in. deep, costing from 2s. to 2s. 6d. per lineal foot, laid complete on a concrete foundation, though in a country district an undressed granite 4 in. wide by 9 in. deep, costing from 1s. to 1s. 6d. per lineal foot, may be substituted, but this certainly looks a little rustic, and has not the workmanlike appearance of a dressed kerb.

Kerbs are also made in blue Staffordshire stoneware in either a bull-nosed, splayed, O.G., or solid pattern of various sizes. A kerb can also be constructed of cement concrete blocks, or with concrete *insitu*, by means of plank moulding rigidly fixed in place, and removed after the concrete has set. This kerb is suitable for a street of poor class property where it is essential to study economy.



12. STREET HYDRANT FOR FILLING WATER-CARTS

The concrete should be of the best materials—*i.e.*, good Portland cement and thoroughly clean shingle, ballast, or broken stone in proper proportion and well mixed.

In France wrought and cast iron kerbs are used, and these have recently been introduced in some towns in England.

In America fireclay brick kerbs of various shape have been used with success.

In laying kerb it is very important that an experienced man possessing a good eye should be employed to make it appear pleasing to the eye both as regards line and level, as kerb laid the least irregular is very perceptible.

The "skillet line" and "boning rods" are used to assist in securing a straight or curve line.

It has been held that a local authority has no power to compel the kerb of a footpath to be laid in a new street before building operations are commenced.

Specification. The following is an abbreviated clause for the specification:

Lay the granite kerb in a dead straight line with uniform longitudinal gradients, and so as to bone accurately through from point to point. The kerb is to be laid on 4 in. of cement concrete, 15 in. wide, with a fall of $\frac{3}{8}$ in. outwards towards the channel, each stone to be bedded solid and well beetled down into position with close butt joints.

The butt joints are to be well grouted in with one part of cement to two parts of fine sand, each joint to be completely filled and finished with a neatly-cut joint.

The channelling is to be laid on 4 in. cement concrete, 12 in. wide, to uniform gradients 4 in. below the top edge of the kerb, except where otherwise specified or directed by the engineer, and with a cross fall of 1 in. towards the kerb, each stone bedded solid and well beetled down into position with close joints.

The butt joints and the joint between kerb and channel are to be grouted in and finished as specified for the kerbing. All channelling to be laid so as to break joint with the kerbstones. A circular kerb is to be accurately laid in the position shown upon the drawings, so as to continue the line of kerbing in a uniform curve of proper radius, with proper radiating joints, which are to be accurately fitted on the spot if necessary.

Where kerb has to be relaid it is to be carefully taken up and relaid on concrete in the manner described for new kerb, and lowered or raised to new level as required.

Any existing kerbstones which the surveyor may deem unsound or defective is not to be reused. The contractor is to include in his price for reworking, back-jointing, and squaring ends of any kerbs which have to be relaid.

All gully tanks to be supplied with 6 in. outlet and movable grating of strong bars, each grating to weigh not less than 2 cwt. 25 lb.

A row of granite setts laid as headers on cement concrete 4 in. in depth, and grouted as specified for channelling, to be laid around all gully gratings, and splayed at each end to meet the water channel.

All kerbing and channelling should be laid previous to the formation of the carriage-way.

Continued

Group 9 **DRESS** **16** TAILORING continued from page 2208	# AN EMPIRE COAT **Drafting and Making an Empire Coat. Materials Required and Measurements. How to Cut Bodice for a Stout Figure. Making Up**

continued from page 2208

By Mrs. W. H. SMITH and AZÉLINE LEWIS

THE Empire is a very popular style at the moment, and is equally suitable for street or evening wear. Its principal feature is a short body of a slightly loose fit extending about 4 in. below the bust, which lends itself to various modes of trimming [**78**].

Materials Required. From 2½ to 3 yd. of 54-in. cloth, ¾ yd. sleeve lining, and 4 yd. single-width for bodice and skirt; ¾ yd. canvas.

MEASUREMENTS. This is drafted to a back length of 16 in.; chest, 34 in.; sleeve, 20 in. from centre-back to elbow; elbow to wrist, 10 in. Working scale, half chest (17 in.); ¼ in. turnings are allowed on all seams.

78. EMPIRE COAT

The Drafting. For the system, see Ladies' Princess Robe.

Square the lines at right angles from A, B, and C, as in previous draft [**67**]. C to D, 4 in.; this is for the short waist, and can be made shorter or longer as desired. D to 1, 2 in. Draw line from 1 to A. Back line to C^a, one-third of chest (5⅝ in.), on to F, two-thirds less ½ in.; on to G, half chest (17 in.); G to H, 3 in.; C^a to I, one-twelfth (1⅜ in.). Square line up from C^a to B line; make J ½ in. above the line; J to J^a, half the distance from A to C [see broken line]. This is the back pitch of sleeve. Draw shoulder line from J to A_b, and neck curve from A^b to A. Square up from F, make F^a one-fourth of chest, plus ¾ in. (5 in.); F^b, midway between; F^b to X, ¾ in. Draw line from 1 to K, half the chest plus 3 in., K to 2, 1 in. Square up from G, make L on neck line, continue neck curve, shoulder, and armhole curve as in previous draft; draw line from K through H to H^a. This should not be so wide if the bolero is to be left open to show the blouse.

Back line to I^a, half chest, 8½ in. Square line down from I^a to short waist and make a dot; 3 and 4 are ½ in. to the left and right of the dot. Draw lines from 3 and 4 to I^a. Three-quarters of an inch up from bust make a dot on armhole curve for inset of sleeve.

Raise A and A^b ½ in., connect A^b to shoulder line. M^a to S, ½ in. This is to form a little stand for the neck, but if it is not to fit closely the two last additions are not needed. Make a dot 2 in. to the left of H^a and draw line from H through the dot to S. Draw line from 2 to H. The broken lines indicate the position of trimming [**79**].

To obtain a shaped trimming to simulate a collar, place the shoulders together evenly and trace through the broken line—this can be made deeper if desired.

When cutting the collar avoid having a seam in the back. The trimming can be of galoon, braid, lace, silk, velvet, or embroidery.

Trace the pattern off. The front must be traced from 2 to H on to S, unless a rever is desired. In this case it must be traced round H^a. This drafting will do for the bolero in *d*, **71** [page 2205].

Skirt for Coat. Square lines at right angles 2 in. down from top of paper, and 5 in. in from edge; letter the corner D. D to F, 11 in.; D to 1, 2 in; 1 to 2, 1 in. Draw line from 1 through E; 34 in. down make E^a. 1 to K, 1 in. more than 1 to K on body draft. This extra inch is for easing on [**80**].

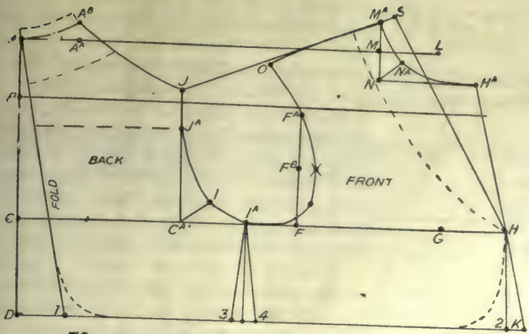
Square line down from K, 11 in., make dot 2 in. to the right. Draw line from K through the dot the length of skirt plus 1 in. (35 in.); make K^a. 1 to 3, 8½ in.—*i.e.*, 1 in. more than 1 to 3 on body draft. 3 to 4, 1 in.

Square a line down from the centre of 3 and 4, 11 in.; make L. Dots 5 and 6 are 2 in. to the right and left of L. Draw lines from 3 through 5 the length of skirt (34 in.); make M; 4 to N, the same. Draw lines from K^a to N and from M to E^a. Continue the lines from 1 to 2 and side lines from 3 and 4 to 1 in. above, and make 7 and 8. Curve from K to 8 and from 7 to 2. N to 8 is the front gore, M to 7 is the back gore. Trace the pattern off, round the outlines.

82. LARGE-SIZED BODICE

The sleeve is drafted as for ladies' tight-fitting jacket with the following exceptions: Five and a half inches are left on for extra fulness at the top, 3 in. at the elbow portion, and 3 in. at the wrist. The sleeve can, of course, be cut any length desired [see broken line in diagram **81**].

In cutting the fronts of skirt, leave a 3-in. inlay for facing.

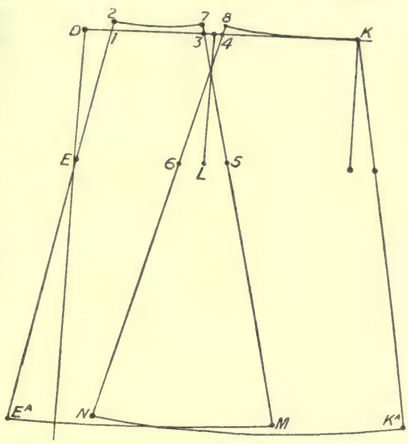


79. DRAFTING BODICE OF EMPIRE COAT

The bodice must have a facing cut to shape, about 2 in. wide. Chalk and thread-mark the various parts as in previous lessons.

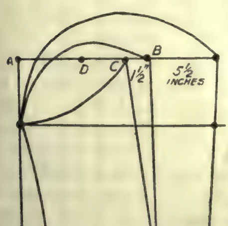
The Making. Baste the canvas to the fore parts of bodice, and put the linen stay on as previously shown.

The facing must be put on, stitched, pressed, and felled, as in ladies' coat. The question of fastenings must now be decided. If hooks and eyes, they must be put on before the facing is arranged; but if cord-loops and buttons, then the former must be sewn on when the facing is done. The neck must be stretched in the gorge to make it fit well at that part. Join the fore parts to the back; press, and trim the bodice portion according to taste or the prevailing fashion. The bodice is then ready to be lined.



80. DRAFTING SKIRT OF EMPIRE COAT

We now proceed with the skirt. A strip of canvas 2 in. wide should be put down the fronts, also a linen stay. Baste the facing to the canvas and fell, and proceed with the making as for coat.



81. SLEEVE FOR EMPIRE COAT

After having lined the skirt, the bodice must be attached to it in this manner. Place the edge of bodice to the edge of skirt, face to face, with the skirt towards the worker. Turn the linings of bodice and skirt back while basting together. Secure centre-back of bodice to centre-back of skirt. Now baste the skirt to the bodice, placing the side seams of skirt to the underarm seams and easing in the fulness that has been allowed.

Stitch and press, then baste the skirt lining to the bodice, and fell the lining of latter over the skirt.

The Sleeve. This is made as for coat, but the top part must be well eased at the elbow. The bottom can be gathered and put into a small gauntlet, or it can have small pleats about 6 in. deep. Should a three-quarter sleeve be preferred, it must be cut off at the broken line—*i.e.*, 4 in. down from elbow and 3 in. in front.

Care should be taken to keep all the edges as thin as possible, and it should be remembered that good pressing is essential.

Bodice for Stout Figure. The bodice given is for an erect stout figure, very hollow in the waist, and very full round the hips. The stouter the figure below the waist in front, the higher the waist line is thrown. The measures for this part must be taken very tightly under the bodice [**82**].

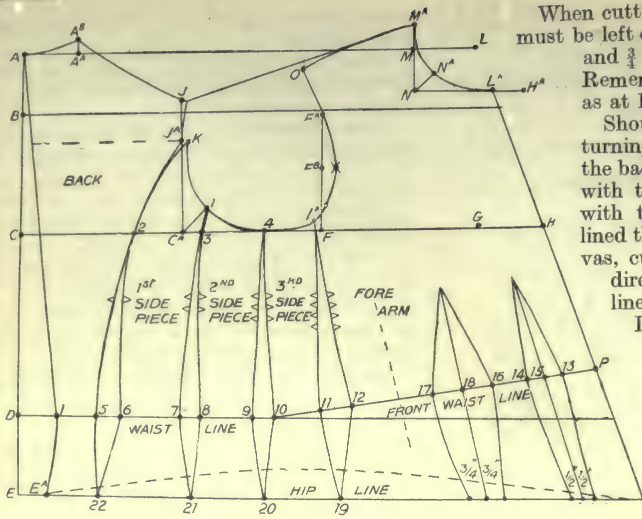
MEASUREMENTS. Neck, 15½ in.; length of back, 15¾ in.; chest, 40 in.; bust, 44 in.; waist, 31 in.; centre-back to elbow, 20½ in.; elbow to wrist, 10 in.; elbow 12 in.; wrist, 9 in.; front length, 19½ in. Working scale, half chest (20 in.).

It will be noticed that the indentation in centre-back is more than is given in previous lesson, which is due to the figure being so hollow at that point. For a stooping figure, the back is generally very much longer, and the front correspondingly shorter.

Square lines at right angles from A, B, C, and D, as in previous lessons [**83**]. D to 1, 2 in.; D to E, 3 in.; E to E^a, 1½ in. Draw back line from E^a through 1 to A. Back line to C^a, one-third of scale less ½ in. (6¼ in.); to F, two-thirds less 1 in.; to G, half scale less ¾ in. (9¼ in.); to H, half bust plus ½ in. (22½ in.); F to F^a, one-fourth of scale (5 in.); F^b, midway between; F^b to X, ¾ in.; C^a to I, one-twelfth (about 1½ in.).

Square up from C^a to ½ in. above B line, make J; J to J^a, half the distance from A to C [see broken line]; J^a to K, ⅜ in. Draw shoulder line from A^b to J.

Proceed as in first lesson to obtain neck curve, shoulder, and armhole, the only exception being that M^a should be 1 in. instead of 1¼ in. H^a to L^a, 1¼ in. Draw lines from L^a through H to hip line; M^a to P, front length less 2¾ in.—*i.e.*, the back neck measure as from A to A^b—F to I^a, ½ in. Divide the distance between back line and I^a into four parts, putting one-third plus ½ in. in the back, as at 2, and the remaining 7½ in. into three equal parts of 2½ in.; make dots 3 and 4.



83. DRAFTING LARGE-SIZED BODICE

Waist Suppression. 1 to 5, 1½ in.; the side pieces should be ½ in. less on the waist than on the bust line.

The Indentations. 5 to 6, 1 in.; 7 to 8, the same; 9 to 10, 1¼ in.; draw line from 10 to P (this is waist line proper); 11 to 12, same as 9 to 10. Draw the lines of side pieces and curve from 5 through 2 to J^a, and from 6 through 2 to K.

Measure up the waist of back and side pieces (total 7½ in.); place this amount on 12, and make a dot at half the waist measure. The distance from the dot to P (3½ in.) is to be taken out in darts.

P to 13, 2 in.; 13 to 14, width of first dart (1½ in.); 15 in the centre; 14 to 16, 1¼ in.; 16 to 17, width of second dart (2½ in.). We are allowing ½ in. extra in the second dart as the waist stretches. 18 is the centre of 16 and 17.

Draw lines through the centre of each dart (parallel with front line) from hip to within 2½ in. of bust line; make dots ½ in. to the right and left of first line (on hip line), and curve through 13 and 14 to top of dart. The dots on second dart should be ¾ in. to right and left, and curved in the same manner as the first. Now make a dot in the centre of 11 and 12. Square down from the dot and make 19 on hip line. Curve from 19 to 11 and 12. Treat the two next indentations in the same manner, making 20 and 21 on hip line, and 22 below 5, and curve to 5 and 6.

A wrap 1½ in. wide should be left on the front.

Sleeve. Refer to Ladies' Tailoring for sleeve of tight-fitting jacket, as we are giving the exceptions only. No turnings are allowed in this draft. Work to 1 in. less than half scale—*i.e.*, A to B, 9 in., instead of 10 in.; A to D, D to F, and F to H are each 4½ in. [84].

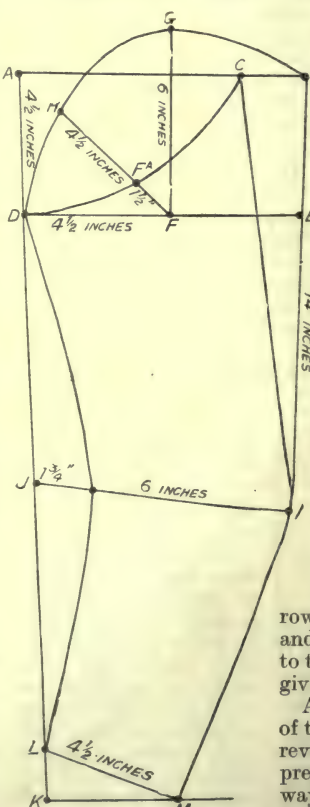
Cut out the pattern round the various outlines.

The Making. Chalk and thread-mark the patterns as in previous lessons, not forgetting to leave the inlays on shoulder and forearm, and to put in the balance-marks.

When cutting the fore parts, from ¼ to ½ in. must be left on right fore part for buttonholes, and ¾ in. on the left for button stand. Remember to stretch the back of darts, as at 14 and 17, when basting [83].

Should the material be ravelly, good turnings should be allowed, and, if thin, the back and side pieces should be lined with thin linen, stitched in the seams with the cloth. The fronts must be lined throughout with thin tailors' canvas, cut on the cross and inserted as directed in previous lesson. Place a linen stay along the edge, and press. If the bodice is to be buttoned, the right fore part must have a facing of material, 1½ to 2 in. wide, put on in the same manner as on the front edge of jacket.

The basque can be shaped as desired; for pointed bodice, see broken line. It should have a strip of linen on the cross about 1 in. wide, basted to the edge. Turn up the bottom and baste to lining and canvas, and well press the basque and fore parts. Insert the bones as in Princess robe. It is advisable to insert an extra bone in the fore part of this bodice [see broken line in diagram for position].



84. DRAFTING SLEEVE FOR LARGE-SIZED BODICE

Line the bodice as directed for coat and Princess dress. When felling round the basque, hold the facing a shade tight. The button stand and basque are generally faced with silk or Italian, the same colour as material.

The sleeve is made and inserted as in Princess robe; whilst the collar, which should be a little narrower, is also made and put on according to the directions there given.

As to the trimming of the bodice in 82, the revers and cuffs are prepared in the same way as those already drafted, and are made as directed in the previous lesson.

Continued

COOKERY RECIPES

Methods of Preparing and Cooking Various Breakfast Dishes, Cakes, and Beverages. Vegetarian Cookery. Kitchen Economy

BREAKFAST DISHES

Oatmeal Porridge

INGREDIENTS. One teacupful of coarse Scotch oatmeal, one pint of water, half a teaspoonful of salt.

Method. Put the water into a clean enamelled pan, add half a level teaspoonful of salt. Bring the water to boiling point. Dredge in the oatmeal and stir well, using a wooden spoon, or, better still, a Scotch porridge-stick, which resembles a small rolling-pin. Let it simmer about forty minutes, keeping it well stirred. If the oatmeal absorbs too much water and becomes too thick, add more. Serve quickly in very hot porridge bowls or small soup plates. It should be thick but not rocky. Serve with cold milk, cream, sugar, or salt. Prepared oats may be used, and take far less time to cook, though many prefer the ordinary oatmeal.

Brawn

INGREDIENTS. Half a pig's head, salt and pepper, four or more pounded cloves.

Method. Wash the head very carefully in tepid water and remove all the brains, veins, and splinters of bone. Next put it in a pan with enough cold water to cover it and two teaspoonfuls of salt; bring it to the boil, skim it well and let it cook steadily for from one and a half to two hours, or until the bones can be easily drawn out. Then take out all the bones, cut the meat into neat small squares; this should be done near the fire or the fat will set before it is finished. Put the meat on a plate, sprinkle it well with salt, pepper, and clove; mix well together, then pack it into a round mould or cake tin unless you have a proper brawn mould. Put a plate with some weights on the top of the tin to press the meat firmly together, and leave it till next day. Then dip the tin entirely into warm water, and the brawn will turn out easily. The liquor from it may be used for pea soup, and the fat from the surface may be clarified as will be directed later in the article on Kitchen Economies.

Buttered Eggs with Mushrooms

INGREDIENTS. A quarter of a pound of mushrooms, three eggs and one extra yolk, salt and pepper, a little milk, one ounce of butter.

Method. Stalk and carefully peel the mushrooms. Cut them in small pieces, put them in a pan with milk to cover them, and stew them gently till they are tender; then add to them the beaten yolk of the egg and one tablespoonful of milk, and keep this hot while the buttered egg is being made. Break the three eggs into a basin, dust them with salt and pepper, and beat them up. Melt the butter in a small pan; when it is hot pour in the eggs and one tablespoonful of milk, stir them quickly over a slow fire till they are lightly set. Have ready some neat pieces of buttered toast. Spread the mushroom mixture on them, then heap the buttered egg on that, shake a little chopped parsley on each, and serve.

Tomatoes, shrimps, anchovies, or kidneys may be used instead of mushrooms.

Scallops of Cold Meat

INGREDIENTS. Half a pound of cold meat or poultry, one ounce of butter, half an ounce of flour, half a pint of stock, browned crumbs, a teaspoonful of chopped parsley.

Method. Well butter four or six scallop shells. Chop or mince the meat. Melt half the butter in a small pan, stir in the flour smoothly; then add the stock and stir over the fire till the sauce boils. Season it carefully and add enough of it to the meat to make it nicely moist; stir in the parsley also. Put the mixture in the buttered shells, shake a good layer of browned crumbs over the top of each and put a few tiny bits of butter here and there on top. Put the scallops in the oven to get quite hot through, then serve them on a folded napkin.

Kidney Omelet

INGREDIENTS. One sheep's kidney, one and a half ounces of butter, pepper and salt, a quarter of a teaspoonful of parsley, a quarter of a teaspoonful of onion, two eggs.

Method. Break the eggs carefully, putting the yolks into one basin and whites into another. Work the yolks with a wooden spoon till frothy. Skin and core the kidney and cut it up into small pieces. Melt half an ounce of butter in a small pan, and cook the kidney in it; then add it, the salt and pepper, parsley and onion to the yolks, and mix well. Put one ounce of butter in the omelet pan (or a small frying-pan), let it get very hot and then brush it all over the pan. Now whisk the whites to a very stiff froth, add them to the other ingredients and mix very lightly. Pour the mixture into the pan. Place it over a quick fire for three minutes. Then put it in a moderate oven to set and slightly brown. Slip it out on a very hot dish. Fold one half over the other like an envelope and serve at once.

CAKES

Plum Cake

INGREDIENTS. Half a pound of butter, half a pound of castor sugar, three quarters of a pound of flour, one teaspoonful of baking-powder, six eggs, half a pound of sultanas, half a pound of mixed peel, a quarter of a pound of glacé cherries, a quarter of a pound of ground almonds, half an ounce of spices, one ounce of sweet almonds, half a gill of milk, half a teaspoonful of salt.

Method. Line a cake tin with two layers of greased paper. Cream together the butter and sugar. Whisk the eggs and add them. Sieve together the flour, baking-powder, and salt, then add them lightly to the eggs, etc. Prepare

the fruit, chop the peel and cherries, then add them, also the almonds, spice and milk; mix all well together, put the mixture into the prepared tin, sprinkle an ounce of chopped almonds over the top, and bake it in a moderate oven for about one and a half hours.

Gingerbread

INGREDIENTS. Five eggs, half a nutmeg grated, a quarter of an ounce of ground ginger, a quarter of a teaspoonful of pudding spice, half a pound of castor sugar, nine ounces of flour, six ounces of peel, four ounces of almonds, a quarter of an ounce of carbonate of soda, two tablespoonfuls of milk.

Method. Whisk the eggs in a basin, add to them the spices and sugar, and beat well for five minutes. Sieve together the flour and carbonate of soda and add them; shell and chop half the almonds and add them, also the chopped peel and the milk. Mix all well together, turn it into a deep baking tin, which should be lined with greased paper; put the rest of the almonds, which should be halved, over the top, and bake it in a moderate oven for three-quarters of an hour. Watch it carefully, and if it begins to get too dark lay a piece of kitchen paper across the top.

Swiss Roll

INGREDIENTS. Three eggs and their weight in butter, sugar, and flour, two tablespoonfuls of milk, vanilla, one teaspoonful of baking-powder, jam.

Method. Cream together the butter and sugar. Sieve together the flour, baking-powder and a pinch of salt, then add these lightly to the butter, etc. Lastly, add the milk, spread the mixture in a shallow baking tin lined with greased paper, and bake it in a moderate oven till it is set and a delicate biscuit colour. Turn it on to a piece of paper which has been dusted with castor sugar. Warm a little raspberry jam in a small pan, spread it over the cake, then roll it up neatly; do this as quickly as possible, as if it gets too cold it is liable to crack in the rolling. Any jam that has no stones may be used.

Petits Gâteaux

INGREDIENTS. Half a pound of castor sugar, half a pound of ground almonds, two ounces of cornflour, six eggs, red currant jelly, two lemons.

Method. Brush some small fancy cake tins with melted butter, mix together two extra teaspoonfuls of cornflour and castor sugar, dust the inside of each tin with this, shaking off all that will not stick. Put the yolks of the eggs and the sugar in a basin and beat them till frothy, then add the almonds, grated lemon rind and juice, and lastly the cornflour. Whisk the whites of the eggs to a very stiff froth, and add them very lightly to the mixture. Half fill the tins with it, then bake them in a moderate oven till they are set. Take them out of the tins, and put them on a sieve to cool; when they have cooled slightly, scoop out a little from the centre of each, and put in a little piece of red currant jelly.

Bath Buns

INGREDIENTS. One and a half pounds of flour, half a pound of butter, a quarter of a pound of castor sugar, a quarter of a pound of granulated sugar, five eggs, one and a quarter ounces of yeast, four ounces of mixed peel, two ounces of sultanas, three quarters of a pint of milk, one lemon.

Method. Mix the yeast with a teaspoonful of castor sugar till both are liquid; warm the milk slightly and pour it into the yeast. Sieve the flour and a pinch of salt into a basin. Rub the butter lightly into it, then add the castor sugar, the cleaned sultanas, and the grated lemon rind. Mix these together, then beat and add the eggs, and lastly the yeast and milk. Mix all into a smooth dough, put it in a basin, cover it and put it at the side of the kitchen fire to rise for one and a half hours, or till the dough is twice its original size. Then turn it on to a floured board, work in the granulated sugar, keeping back a little to shake over each bun. Put small rough heaps of the mixture on a greased baking tin, sprinkle some granulated sugar on the top of each, put the buns in a warm place to rise for twenty minutes, then bake them in a quick oven for about the same length of time. Put them on a sieve to cool.

Chocolate Cake

INGREDIENTS. Half a pound of butter, a quarter of a pound of castor sugar, half a pound of good plain chocolate, four eggs, a tablespoonful of milk, three ounces of cornflour, two ounces of ground rice, a small teaspoonful of baking-powder, chocolate icing.

Method. Cream together the butter and sugar, then add the eggs one by one, beating each one well in. Grate the chocolate, then put it in a saucepan with the milk and melt it slowly over a gentle heat, and add it to the butter, etc. Sieve together the cornflower, ground rice, and baking powder, add these to the other ingredients. Pour the mixture into a small cake tin lined with three layers of greased paper and bake it in a moderate oven for about one hour. Watch it carefully as it so quickly burns. Leave it till cold, then coat it with chocolate icing and decorate it with crystallised violets, pistachio nuts, or chopped almonds.

For the icing, grate three ounces of good chocolate. Put it on a tin in the oven and let it darken slightly. Sieve half a pound of icing sugar. Put the chocolate in a pan with half a gill of water; let it get hot, then add the icing sugar and stir it with a wooden spoon till it is melted. It should coat the spoon smoothly, otherwise it is too thin. If so, add a little more sugar. Pour it in spoonfuls over the cake and decorate it prettily.

Sally Luns

INGREDIENTS. Three quarters of a pound of flour, half a teaspoonful of salt, one ounce of butter, half an ounce of compressed yeast, one egg, one and a half gills of milk, a quarter of a teaspoonful of castor sugar.

Method. Mix together the flour and salt, then rub in the butter. Cream the yeast and sugar together till they are liquid. Warm the milk till it is just tepid and mix it with the yeast. Beat up the egg and add it to the milk, then strain the milk, etc., into the middle of the flour, and mix it lightly in. Turn the paste on to a floured board, and knead lightly, using a little

flour to prevent it sticking. Well grease two high round cake tins. Divide the dough in two, make each into a round cake, and drop it into the tin; twist a piece of greased paper over the tops and put them to rise till the dough fills the tins. Probably they will take one hour. When risen enough, bake in a quick oven about half an hour; turn them out and brush them over with a little warm milk and butter.

Shortbread

INGREDIENTS. One pound of flour, half a pound of butter, four ounces of castor sugar, one egg.

Method. Put the butter into a large basin, work it with a wooden spoon or the hand till rather soft. Add the sugar and egg, mix together lightly, add the flour gradually, kneading it well. Shape into two or more round cakes according to the size required. Decorate the edges, prick the cakes well over with a fork. Bake very slowly till they are a very pale brown. Dust with sieved castor sugar, but do not move them till cold.

Plain Soda Cake

INGREDIENTS. One pound of flour, six ounces of butter or dripping, six ounces of castor sugar, six ounces of sultanas, two ounces of candied peel, one teaspoonful of carbonate of soda, half a pint of milk, one egg.

Method. Line a cake tin with greased paper. Cream the sugar and butter till they look white and soft, then beat in the egg. Clean and stalk the sultanas, chop the peel, mix the flour and carbonate of soda, stir them lightly to the butter and sugar. Add the milk, mix well together. Put the mixture into a tin, bake it in a moderate oven for about two hours, or till a skewer pushed through the centre of the cake comes out quite clean.

Rice Buns

INGREDIENTS. Half a pound of castor sugar, a quarter of a pound of butter, four ounces of flour, eight ounces of ground rice, one teaspoonful of baking-powder and two eggs.

Method. Mix together two extra teaspoonfuls of flour and the same amount of castor sugar. Then grease some patty tins, put a little of the mixture of flour and sugar in each, shake it all over and turn out all that does not stick, leaving the tin thinly coated all over. Mix together the flour and ground rice. Cream together the butter and sugar, then add to them half the flour and rice and one egg. Mix well together, then put in the rest of the flour and rice (all but one teaspoonful) and the other egg, and, lastly, add the baking-powder with the teaspoonful of flour. Stir it all well together, Put the mixture into prepared patty tins, and bake in a moderate oven for from ten to fifteen minutes. When done turn the buns out and put them on a sieve till cold.

Almond and Chocolate Biscuits

INGREDIENTS. Four ounces of ground sweet almonds, four ounces of castor sugar, two ounces of grated chocolate, one teaspoonful of powdered cinnamon, three whites of eggs.

Method. Mix the almonds with the castor sugar, the grated chocolate, and the powdered cinnamon. Mix and rub thoroughly together. Take the whites of the eggs, and beat them to a very stiff froth. Stir them lightly to the almond and chocolate mixture. If it seems to be getting very moist leave out some of the whites as it must be a stiff mixture. Line a flat baking tin with buttered paper, put little rough heaps of the mixture on it at a good distance apart, and bake very carefully in a slow oven till crisp. Take every precaution to see they do not burn.

BEVERAGES

Lemonade

INGREDIENTS. Two or three lemons, two ounces of lump sugar, one quart of boiling water, a few lumps of ice.

Method. Peel the lemons very thinly, and carefully peel off all the pith, otherwise the lemonade will have a bitter flavour. Cut the lemon into thin slices, taking out all the pips, and then put the peel, slices of lemon, and sugar in a jug, and pour over them the boiling water. Cover the jug and let the lemonade stand till it is cold, then strain it into a glass jug, pressing the slices well. Before serving it, add a few thin slices of lemon and a few lumps of ice.

Lemon Squash

INGREDIENTS. Small lumps of ice, the juice of one lemon, two teaspoonfuls of castor sugar, soda-water.

Method. Fill a tumbler half full with the lumps of ice, then strain on to it the juice of the lemon, add also the castor sugar. Then fill the glass up with soda-water, and mix all well together. This beverage is usually prepared at the table.

Iced Coffee

INGREDIENTS. Four large tablespoonfuls of coffee, a few grains of salt, one quart of boiling water, three tablespoonfuls of castor sugar, half a pint of cold milk, half a pint of cream, ice.

Method. Put the coffee and salt into a jug, pour on to it a quart of boiling water. Cover the jug and place it at the side of the fire for ten minutes, then pour a few cupfuls of coffee backwards and forwards to clear it. Cover the jug again, and let it stand for ten minutes for the coffee grounds to settle. Then strain the coffee through a piece of fine muslin, add to it the sugar, milk, and cream, or, if more convenient, use all milk. Place the jug containing the coffee in ice for from four to six hours. Just before serving add two or three lumps of ice.

Claret Cup

INGREDIENTS. One bottle of claret, two bottles of soda-water, two glasses of sherry, a quarter of a pound of castor sugar, one lemon, three strawberries, a sprig or two of borage, two or three inches of cucumber, half a pound of ice.

Method. Slice the lemon and remove the pips, also cut the cucumber into thin slices without peeling it. Put all the ingredients into a large glass jug and let them stand one hour. Remove the cucumber, borage and lemon, add the ice, and the claret cup is ready.

A Cup of Chocolate

INGREDIENTS. About one ounce of good chocolate to each breakfastcup of milk.

Method. Buy either cakes or powdered chocolate. Melt it in a cup with a tablespoonful of milk. Bring the milk to the boil, pour it on the chocolate, put it in a clean saucepan, and whisk it with a fork or small egg-whisk till it boils. Sweeten it to taste, then serve it at once with a teaspoonful of whipped cream on the top. If preferred less rich, add more milk.

Coffee

INGREDIENTS. Allow a good tablespoonful of coffee for each breakfastcupful wanted, boiling water, a pinch of salt.

Method. The following is a simple method. Put the coffee and a pinch of salt into a warmed jug, pour on it the boiling water; cover the jug and let it stand at the side of the fire for five minutes, then pour a cupful backwards and forwards four times. Cover it and let it settle. Pour it gently off into a warmed coffee-pot and serve with it hot milk. When possible, buy coffee berries and grind them at home. If that is impossible, buy at a shop where the coffee is freshly ground each day; this makes a great difference in the flavour. If the flavour of chicory is liked, add about two tablespoonfuls of it to each pound of the coffee.

Tea

INGREDIENTS. Allow, unless the party is a large one, a teaspoonful for each person, boiling water.

Method. Take care all stale leaves have been washed out of the pot; heat it with boiling water, then put in the tea and pour on *freshly-boiled* water. Let it stand for from three to four minutes. If the water has been boiling for some time the tea will lose its delicate flavour, and will taste flat. Cheap teas are bad economy, as a much larger quantity has to be used. If the party is a large one it is better to make it in two tea-pots.

Barley Water

INGREDIENTS. Two ounces of pearl barley, one lemon rind, one quart of boiling water, four lumps of sugar.

Method. Put the barley in a saucepan with half a pint of cold water, bring it to the boil, and boil it for a minute or two, then strain off the water. Put it back in the saucepan with the thinly-pared rind of the lemon, the sugar, and boiling water. Let it boil gently till the water is as thick as good cream. Then strain it off, and it is ready. It is invaluable in a sick-room.

VEGETARIAN COOKERY

Macaroni à l'Americaine

INGREDIENTS. Six ounces of ribbon macaroni, one ounce of flour, one ounce of butter, half a pint of tomato pulp, browned crumbs.

Method. Boil the macaroni till tender in plenty of fast-boiling salted water, then wash it under the cold-water tap. Melt the butter in a saucepan, add the flour smoothly, then the tomato pulp; stir it over the fire for a few minutes, then pass it through a sieve and season it carefully. Cut the macaroni into two-inch lengths, and add it to the sauce. Make it hot, turn it into a pie-dish, sprinkle the top with browned crumbs. Serve it with a border round the edge of the dish of nicely-fried sippets of bread.

Fricasseed Eggs

INGREDIENTS. One pint of milk, one large onion, two cloves, one carrot, a small bunch of parsley, four or more eggs, two ounces of butter, one and a half ounces of flour, a few slices of bacon.

Method. Put into the saucepan the milk, onion, cloves (stuck in the onion), carrot, and parsley. Let these simmer for half an hour. Boil the eggs for about twenty minutes till they are hard. Then shell them and cut them in half. Melt the butter in a pan, add the flour, and stir it in smoothly. Next strain in the milk, and stir over the fire till it boils and thickens. Season well with salt, pepper, and a few drops of lemon juice. Then put in the eggs. Let them get very hot in the sauce; take care in moving them that you do not knock out the yolks. While they are heating, cut some raw streaky bacon into neat dice, also some stale white bread. Fry both a pale brown. Chop finely two teaspoonfuls of parsley. Arrange the eggs on a hot dish; pour the sauce over them. Put little heaps of fried bread and bacon, or chopped parsley, alternately round the edge.

Tomato Pie

INGREDIENTS. Three-quarters of a pound of rough puff pastry, a quarter of a pound of macaroni, two teaspoonfuls of chopped parsley, one and a half pounds of tomatoes, one ounce of butter, three-quarters of an ounce of flour, two hard-boiled eggs, half a pint of water, salt and pepper.

Method. Break the macaroni into pieces about an inch long, throw them into a pan of fast-boiling water, and let them boil till they are tender, then drain off the water. Butter the inside of a pie-dish, put in a layer of sliced tomatoes, then a layer of cooked macaroni, next a good sprinkling of salt, pepper, chopped parsley, and onion, then another layer of tomatoes, and so on till the dish is full. Arrange the eggs, cut in slices, on the top. Melt the butter in a small saucepan, add the flour, and fry it a pale brown; next pour in half a pint of cold water, and stir it over the fire until it boils. Season it with salt and pepper. Pour the sauce into a pie-dish. Cover the dish with the pastry as you would an ordinary pie, and decorate it prettily with leaves and a tassel of pastry. Brush the top of the pie with beaten egg to glaze it, and bake it in a quick oven for about three-quarters of an hour.

Beetroot, Lentils, and Egg Sauce

INGREDIENTS. One pint of lentils, one quart of water, a bunch of parsley and herbs, one large onion, two ounces of butter, one or two beetroots, egg sauce.

Method. Wash the lentils and put them to soak in water overnight. Next put them in a saucepan with the water, herbs, and onion, and let them boil for about one and a half hours,

or till they are soft. Then drain off the water, and rub the lentils through a sieve. Boil the beetroot till tender, taking care none of the little rootlets are broken or it will lose its colour. Melt the butter in a saucepan, stir in the lentils, and salt and pepper to taste; make it very hot, then pile it up on a hot dish. Pour some good egg sauce over it and arrange a border of slices of beetroot round. Almost any cooked vegetables may be used instead of beetroot.

KITCHEN ECONOMIES

We have much to learn from the French in the matter of economy. To them no scrap of food is too small to be of use, while the average English cook is given to despise them. Perhaps one of the chief items of waste is bread, which is allowed to get stale and is then thrown away. A careful cook can and will utilise every scrap of bread, and will do so without feeding the family on nothing but bread puddings, which to many people seems its one and only destiny. All crusts and scraps of bread should be collected, should be torn up small, put in a baking tin and dried slowly in the oven. They should then be pounded in a mortar, or, failing that, put between two pieces of paper and pounded with a flat iron. If possible, they should then be sieved, and kept in a tin till wanted. It is well to have some dried so slowly that they are not in the least coloured, and others coloured a pretty brown. The former are useful for coating rissoles, fish, fish cakes, and for making puddings of various kinds, while the latter are nice for "au gratin" dishes, and to give a touch of colour to various other dishes.

These crumbs will keep good for months in a tin, but on no account must the lid be put on till they are quite dry. Another use for stale bread is as a substitute for the more extravagant "pulled bread." Pull the bread into small rough pieces, put them on a baking tin and bake them in a moderate oven till they are a pretty golden brown. These are delicious with butter or cheese, or with soup instead of toasted or fried bread. Slices of stale bread or bread-and-butter make excellent fritters. They should be spread with a little jam, sandwiched together, dipped in frying batter, and then fried in hot fat till they are a golden brown.

There are also many excellent recipes for puddings and tarts in which crumbs form part of the ingredients.

Cooked potatoes are another frequent cause of waste. There is no excuse for even the smallest scrap to be thrown away. If the potatoes are whole, slice them, toss them with a little butter in a pan over the fire till they are hot through. Serve them in a hot dish sprinkled with a little chopped parsley.

If the potatoes are at all broken, they can be mashed, made hot with a little butter, milk, salt and pepper, and served as mashed potatoes; or they may be shaped into small balls, brushed over with egg, covered with crumbs and fried a golden brown in hot fat. They are then called potato croquettes.

They are also useful for making fish cakes, meat and potato cutlets, shepherd's pie, etc. Then, again, with a few tomatoes or beetroot and some salad dressing, they make a delicious salad.

The remains of any cold cooked vegetables can be served as a salad with the addition of salad dressing or mayonnaise sauce, while many vegetables can be reheated with butter—such, for example, as green peas or French beans. Many cold vegetables make a pretty garnish for soups or meat dishes—peas, asparagus, cauliflower. It might not be worth while to cook them on purpose to garnish a dish, but if already cooked they would prove a great addition.

There is a use for all scraps of meat. They may be chopped, heated in a pan with a little gravy or stock, seasoned nicely with chopped parsley, onion, salt and pepper, then either be put in a dish, covered over with mashed potato, nicely browned in the oven and served hot as rock pie, or be served on a hot dish garnished with neat sippets of toast as mince; or the mixture might be heaped up on neat squares of hot buttered toast and served as a breakfast or supper dish. Cold meat is also used for rissoles, croquettes, scallops, etc.

Cold fish could be mixed with any fish sauce there happened to be over, then served either in scallop shells with a few browned crumbs sprinkled over them, or in a pie-dish with a covering of mashed potato or boiled rice. Or it might be mixed with the sauce—its own weight in mashed potatoes and a good seasoning—then formed into round, flat cakes, egged, crumbed and fried.

The remains of curry make an excellent breakfast dish if chopped up finely, the meat, sauce and rice mixed all together, made thoroughly hot, and served on croûtons of fried bread, or, if preferred, slices of buttered toast.

It is well to bear in mind when using up cold meat that it will have lost some of its flavour and its nutritious matter, therefore special care should be given to its seasoning, and a little good stock or gravy should be added to it. Again, cooked meat should always be reheated gently; if it is allowed to boil it will become tough and tasteless. The meat to be warmed should be placed on the fire in warm water; if put in cold, all the goodness will be drawn out, and if in boiling water, the meat will be tough.

Plain boiled rice can be made savoury by the addition of a good-sized piece of butter, a little ketchup or Worcester sauce, and, if liked, two sliced tomatoes. This mixture should be served as hot as possible.

Stale pieces of cheese should be grated and stored in bottles; it is useful for macaroni cheese, cheese pudding, etc. Cold poached eggs seem to the unenlightened utterly worthless; but they may be reheated slowly in plain melted butter or parsley sauce, and served on fresh slices of buttered toast with a spoonful of the sauce.

All bones and trimmings of ham should be put in the stock-pot, and so become the foundation of soups and gravies.

All scraps of fat, cooked and uncooked, should be made into clarified fat. They should be cut into small pieces, put into a saucepan with a pint of water to each four pounds of fat, and allowed to cook till the pieces of fat are shrivelled up and the liquid fat is clear; it should then be strained off into jars, and can be used for pastry, plain cakes, and for frying purposes.

By the way, it is quite worth while periodically to purchase "pieces of fat" from the butcher to clarify; it costs usually about threepence a pound, although, of course, if large quantities of meat are consumed in the house there will probably be sufficient fat for this purpose.

Pieces of stale cake, grated or sliced, can be made into delicious puddings by adding some eggs and milk to them, allowing two eggs to a pint of milk. Put the mixture either into a pie-dish and bake it in the oven, or in a greased basin and steam it for from one to two hours.

Sour milk is excellent for scones; it may also be used for cleaning linoleum.

We give three dishes which may be made from scraps which would otherwise be thrown away as waste.

Miroton of Beef.

Ingredients. Two ounces of butter or dripping, four medium-sized onions, one small bunch of mixed herbs, salt and pepper, one tablespoonful of French vinegar, half a pint of good stock, thin slices of cold beef, a few brown breadcrumbs, and some cooked vegetables.

Method. Melt the dripping. Peel and slice the onions, add them to the dripping, and fry them a golden brown. Add the herbs and seasoning, the vinegar, stock, and a pinch of castor sugar. Let it boil for fifteen minutes, keeping it well skimmed; then strain it. Cut some thin slices of beef, cover the bottom of a pudding dish with some of the sauce, then put in a layer of beef, then more sauce, and so on. The last layer should be of sauce, on which a few browned crumbs should be sprinkled. Place the dish in a pan of boiling water, and put it in a hot oven for fifteen minutes. Serve it as hot as possible, and garnish it with nicely-cut cooked vegetables.

Timbales of Cold Meat.

Ingredients. Half a pound of any cold meat, two small tablespoonfuls of breadcrumbs, half a teaspoonful of chopped onion, two teaspoonfuls of chopped parsley, salt and pepper, a little milk, one egg.

Method. Thickly butter some small moulds and decorate them by pressing thinly-cut rings of cooked macaroni over the inside. The butter will hold any decoration in place. Chop the meat and mix it with the breadcrumbs, onion, parsley and seasoning and enough milk to make it rather moist. Beat up the egg and add it to the mixture, then fill the tins with it. Put them in a shallow saucepan with boiling water to come half way up them. Put a piece of greased paper over the top and steam them gently for an hour. Turn them out on a hot dish and pour some brown or tomato sauce over them.

Kedgeree.

Ingredients. One ounce of butter or dripping, half a pound of boiled rice, half a pound of any cold cooked fish, salt, pepper and cayenne, one or two hard-boiled eggs, a little mace, if liked.

Method. Melt the butter in a pan, add to it the rice, fish, and whites of the eggs cut into small pieces. Season it well and make it thoroughly hot. Pile it up on a hot dish and garnish it with some finely-chopped parsley and hard-boiled yolks of egg rubbed through a sieve.

Cookery concluded

PATTERNS AND CASTINGS

Casting from Complicated Patterns. Cored Work. Loose Pieces. Rapping. Taper. Cores. Core and Drop Prints. Shrinkage

continued from page 2114

By JOSEPH G. HORNER

IN the last article we selected cast objects of forms so plain that there was nothing to complicate the delivery of their patterns from the moulds. That is, there were no portions overhanging in the lower parts of the moulds, with overlying sand that could interfere with the ready withdrawal of the patterns. Everything was tapered downwards, and only one sand joint was required between the top and bottom portions of the moulds. But such simple examples only constitute a small portion of the moulder's work. So now we take up some illustrations of castings in which a good many problems not so simple are involved.

Flanged Castings. The figures from 20 to 25 show castings and methods which have resemblances and differences. In castings 20 and 23 there are flanges, one of which, if fast in the bottom of the mould, would prevent delivery of the pattern from the sand. In each there are central bosses; in each there are alternatives that are practical. We will dispose of the bosses first, because only a few remarks thereon are necessary.

The difference between those in 20 and 23 is that the space for sand left between the bosses and the inside edges of the rims is very small in 20, but ample in 23. It would be difficult to lift the sand out of the narrow zone in the former but easy to do so in the latter. The top portion of the boss in 20, therefore, must be attached loosely to the plate of the pattern 21, in this case with a central stud, to come into the sand of the top, and be withdrawn after turning over. But it is not necessary to do so in 24, although it is often done as shown, in order to avoid risks of a breakdown of the sand. Note may also be made of the large amount of *taper* given both to the bosses and to the internal portions of the rim in 21, with a view to easy delivery, though it happens also to coincide with the best form for strength.

Joints. With regard to the delivery of the lower flanges, it is necessary in 20 that the mould should part along *a—a*, so that the lower flange can be taken out after the removal of the top mould and pattern. In that case, the annular tread (*b*) must be fitted loosely in segments round the body of the pattern 21, to be left behind on the withdrawal of the latter, and to be pulled inwards subsequently in a horizontal direction. Or, leaving the projecting portion (*b*) loose might be avoided by jointing the pattern along the plane *c—c* [20]. In that case both flanges would have to be left loose, and sand joints made along the planes *a—a* and *d—d*. The only objection to this is the making of an extra sand joint.

The pattern 21 has its bottom flange (A) as a loose ring. The belt (*b*) is fitted in short lengths, and retained with skewers loosely. The method of building up shown is that adopted in work of this class, to which reference is made in the next section. The mould in 22 comprises now not only a top and bottom, but a *middle* part, requiring a moulding box in three corresponding sections.

Alternatives in Joints. In 23 the sand joints required are two, along the planes *a—a a—a*. To produce these the pattern [24] is differently jointed, either along *b—b*, through the middle, or along one face of the plated centre, one half of the sheave being then fitted as a ring, as shown. This may be a wooden pattern, in which case it is built in segments similarly to 21. Or, as is often done for repetitive work, an iron or brass pattern is made with wooden bosses, interchangeable by means of their central studs. This is the pattern shown by way of alternative in 24. Another alternative is to core the rim out, using an annular print; but that method is rarely adopted, except in the case of wheels that have recesses for chain, and not always then, cores being generally reserved for wheels of large diameter. The device is also employed when broken castings have to be moulded from, in which case a segmental print is rammed round the casting in the mould in successive positions until the circle of the print impression is completed.

Fig. 25 gives a section through the cored mould, with the two joints at *a—a*, leaving a middle ring of sand.

Three-part Joints. Fig. 26 illustrates a bevel wheel and a spur pinion cast together, and both *double-flanged*. Such an example cannot be drawn from the mould unless there are three joints in the sand, at *a*, *b*, and *c* respectively. It is a job for a *three-part* box, not four, as might be imagined, because the thickness from *a* to *b* is made in segmental cores, which involves less trouble than using a shallow moulding-box for the purpose of jointing. For convenience, the pattern in 27 is made with a greater number of joints than the mould, the object of which is to give perfect facilities for ramming, and also for ready delivery of the pattern parts, with the minimum of risk of tearing up the sand. The section of the pattern in 27, by comparison with the casting in 26 and the mould in 28, renders the nature of the work apparent. We have loose pieces again in the shroudings for the teeth, and in the separation of the pinion from the bevel wheel.

Cored Work. Fig. 29 is an example of a different kind from the foregoing, illustrating cored work in which the main core is completely enclosed within the body of the casting.

The roller in this figure is moulded, not as it runs, but flatwise, with its plane faces in top and bottom; not that it could not be moulded edgewise, but because the flat position renders the insertion of the cores easier. The pattern in **30** is built up in segments, the top and bottom sets (*aa*) covering the entire faces, the middle ones (*b*) being narrower and annular. The prints (*a*) will be noted as corresponding with the holes in **29**. There is only one joint in the mould, that at *c—c* [**31**].

The main core for **29** is made in a box, rammed in core sand and dried. Generally, though not always, the shaft holes are made in cores distinct from the body core, as shown in the mould in **31**. The small holes seen in the end plates in **29** and **31** are inserted simply to provide openings through which the core and core irons can be withdrawn after casting. When these are not inserted the work of the fettler is increased unnecessarily. In **31** the core is seen to be built round a skeleton of rings of iron rod.

Drum with Swept-up Core. The drum casting in **32** is moulded as it runs, with its cylindrical axis horizontally, differing in method, therefore, from **29**. One reason for this difference is that the flanges on the drum may "lift" from the sand without being left loosely, while the roller [**29**] has no flanges, but a good coning, which makes the flat way of moulding the obvious one. The pattern is shown in **33**, in half external view, and half section, *a—a* being its joint, corresponding with the mould joint. It affords an example of a method of construction termed *lagging up*, of which more later. The flanges, with boss, facings, and prints, are turned separately from the lagged body, and screwed on its ends.

Fig. **34** is a section through the mould. The core in **34** is swept on a bar—using "hay ropes" and loam—around skeleton core plates, the loam being in a plastic state, the whole mass being dried subsequently before insertion in the mould. When thus swept up, the cores for the shaft holes are swept up also on the bar, and the bar is stiff enough to sustain the weight of the core when laid horizontally in the mould. When a core is made in a box, as for **31**, it is not so well able to sustain its weight as when a bar is used.

The engine crosshead in **35** may be moulded in the manner shown [**38**], or flatwise. The choice is so evenly balanced that crossheads are commonly made either way. The pattern with its prints is shown in **36**, the core box in **37**, and the finished mould in **38**. Observations on the relations of the parts would be superfluous.

Engine Cylinders. These are more elaborated in the cores than in the moulds. Every different design of cylinder presents a distinct set of problems, which has to be tackled irrespective of other types. A comparatively plain example is given in cross-section only [**39**], being one for a particular type of steam crane. Fig. **40** is its pattern, **41** its mould; moulding as shown. Joints are made in the mould at *a—a*, *b—b*, and *c—c*; but only *a* and *c* coincide with the joints of the moulding box, the spaces between *b* and *a* being taken out by means of "false cores" or "drawbacks." There are thus six cores in this example [**41**], the main one (A) for the bore, the two false cores (B, B), two passage cores that do not come in this view, and one exhaust core (C), through which the sections are taken. The pattern for this [**40**] has to be jointed along *a—a* and *d—d*; while the feet over which the false cores are rammed are loosely attached to the cylinder body with screws, to be left behind in the mould until the false cores are lifted, after the delivery of the corresponding half of the pattern body, to which they are attached loosely.

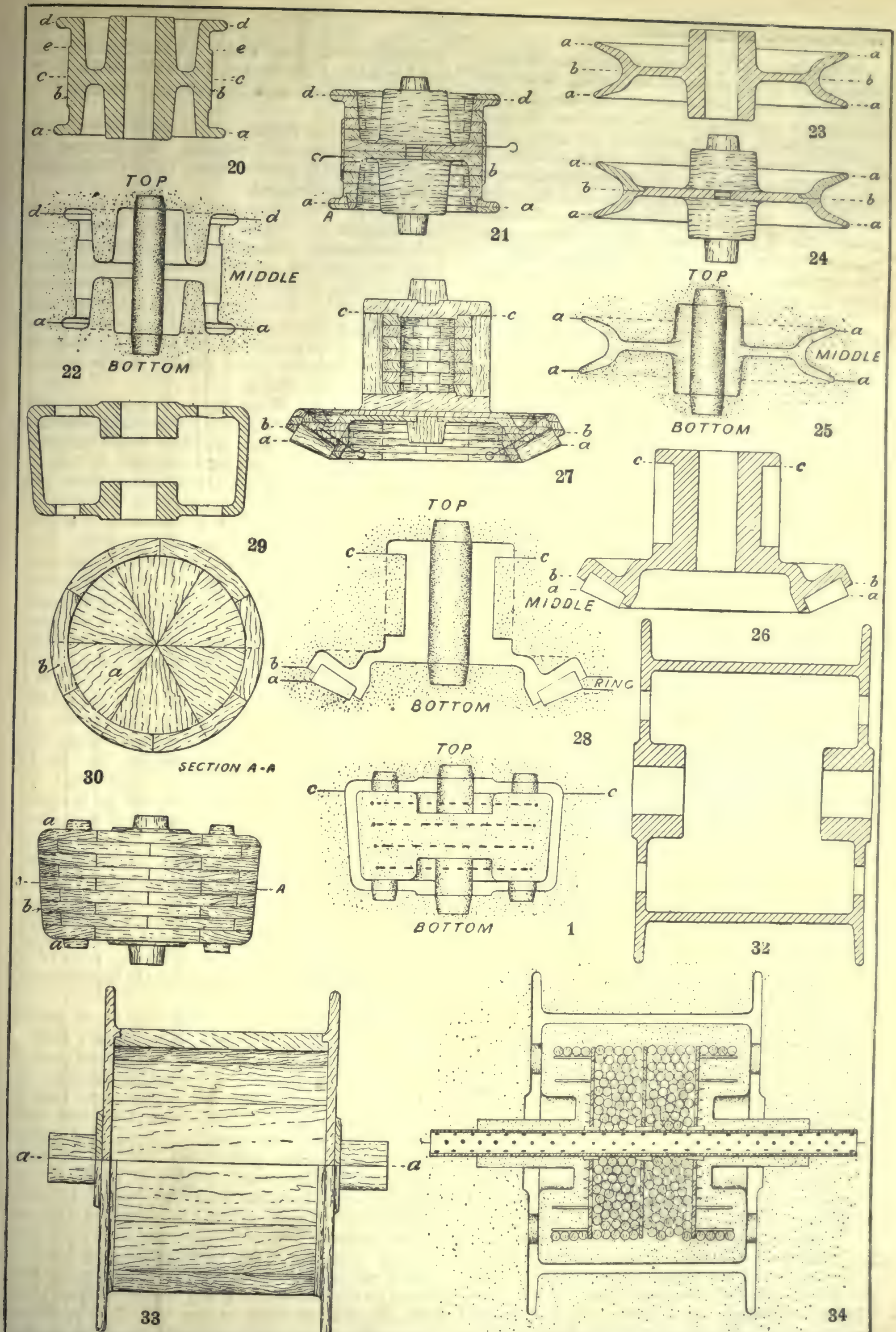
Methods of Delivery. These examples afford a good selection of typical cases of moulding, and we shall occupy some space with further elucidation of some important matters that have been only touched on in passing. We have spoken of the necessity for making provision for getting patterns out of their moulds. This involves not only the jointings shown, but the fitting of loose pieces, and of drawbacks.

Loose Pieces. It is obvious that the mere vertical direction of withdrawal does not cover the case of patterns having portions standing out perpendicularly to those faces, or at angles therewith. Several examples of this kind occur in the figures preceding, in which *loose pieces* are fitted. This term signifies that pieces which cannot be drawn out with the main portion of the pattern without tearing up the sand mould that overlies them are attached loosely, being left behind to be withdrawn subsequently to the main portion. These loose pieces are fitted in many ways, by *skewers*, or *wires*, or loose nails—*i.e.*, nails that are not driven entirely in, but partly only, and so hold temporarily, and also by dovetails. The one essential is that the loose pieces shall be maintained in their exact location during ramming, which is the function of the skewers, nails, or dovetails. The moulder has to withdraw skewers or nails, when sufficient sand has been rammed round the loose pieces, to secure them in relation to the main pattern, but dovetails free themselves in the act of lifting.

Often loose pieces are held temporarily with dowels. A common lathe-bed, shown in section [**42**], will, with previous examples, illustrate typical methods of this kind.

A lathe-bed of the section in **42** may be made to mould in three ways equally well, as shown in **43** to **45**, which give sections through the patterns. In **43** the bed faces are doweled on the bottoms of the ribs, in **44** they are wired at the sides, in **45** the outer pieces are wired, and the interior cored out, for which a print is provided.

A *drawback* [**41*bb***]—the *false core* of the brassfounder—is a little mould within a mould, and fulfils a similar function to the loose pieces—that is, it carries sand that overlies projecting portions of patterns. It is adopted as an alternative, but is also more generally employed when loose pieces would not be suitable, on account of the great width of overhang.



20. Double-flanged wheel 21. Pattern for No. 20 22. Mould for No. 20 23. Sheave wheel 24. Pattern for No. 23 25. Mould for No. 23 26. Bevel and spur-wheel cast together 27. Pattern for No. 26 28. Mould for No. 26 29. Roller casting 30. Pattern for No. 29 31. Mould for No. 29 32. Crane drum 33. Pattern for No. 32 34. Mould for No. 32

Rapping. The *delivery* of patterns, as their withdrawal from the sand is termed, is accomplished by the assistance of *rapping*, for the purpose of loosening the pattern from its surrounding sand. It is effected by inserting a pointed iron bar in the top of the pattern, or in a hole in a special form of plate attached to the pattern, and then striking the bar in lateral directions. The pattern being thus *loosened*, is *lifted* with a screw, and during the process rapping is continued with a wooden mallet on the pattern face to detach it more effectually from the sand.

A result of rapping is that the mould becomes slightly enlarged, and in the hands of careless moulders this often results in inaccurate castings and in badly broken moulds. It is in this work of withdrawal that the moulding machines give superior results to handwork, because the lift is absolutely perpendicular, and the rapping required is nearly nil; or it is often avoided altogether by drawing the pattern through a plate, having a hole cut to the same outlines as that of the pattern, and which holds the sand down, hence termed a *stripping plate*.

Taper. We have said little yet about an important matter to which slight allusion has been made, though it is illustrated in nearly every preceding drawing—that of *taper*, *draught*, or *strip*, as it is variously called.

The way in which taper assists the delivery of a pattern is clear from **46**, in which the withdrawal of a quite parallel piece is contrasted with that of a tapered piece.

The parallel piece A, though drawn halfway out of the mould, as at B, is still as tightly confined by the sand as at first. The tapered piece C, on the contrary, similarly withdrawn, D, is entirely clear of the sand, and requires no effort to withdraw it through the remainder of the way. In B the sand will assuredly become fractured along the course of the dotted lines; while at D no fracture worth mentioning, probably none at all, will occur.

Even though there is taper in a pattern, the pressure and friction of the sand against the deep faces is so great that they could not be withdrawn without fracture of the sand unless the patterns were slightly loosened first by shaking or rapping them.

Amount of Taper. With regard to the amount of taper required no rules can be given. It is a matter for judgment, to be decided in the case of each individual piece of work. Still, some idea can be given of its amount.

If a rib like **46** be 1 ft. deep, the taper will usually range from $\frac{1}{16}$ in. to $\frac{1}{8}$ in. That is, the wood will be from $\frac{1}{16}$ in. to $\frac{1}{8}$ in. thinner at bottom than at top. If a rib were 2 ft. deep, the taper would range from $\frac{1}{8}$ in. to $\frac{1}{4}$ in. If 6 in. deep only, from $\frac{1}{32}$ in. to $\frac{1}{16}$ in. would be given. If 3 in. deep, $\frac{1}{32}$ in. would suffice; if 1 in. deep, the removal of a mere shaving would be sufficient.

Again, take the case of a loose rib which has to be withdrawn, as A in **47**, into the space B of the mould, with the pricker C held in a diagonal direction. In such cases taper much in excess of that given to vertical ribs is imparted, because the withdrawal is an awkward task, and if the sand breaks at the dotted line, as it is likely to do, it is difficult and troublesome to mend it up.

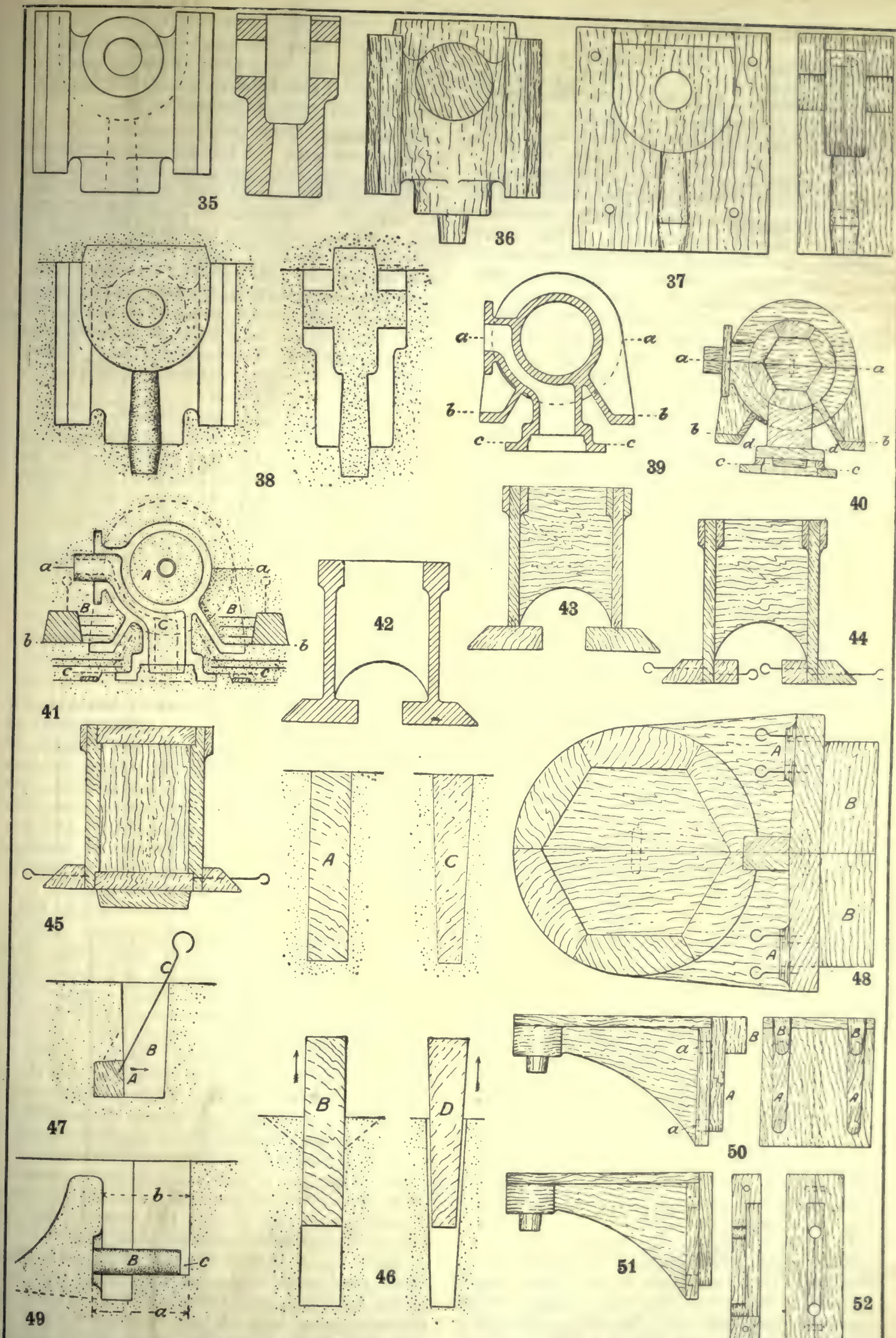
When the top portion of the sand of a mould has to be lifted off a pattern, the amount of taper required is greater than when the pattern is lifted from the sand.

Cores. The formation of hollow spaces is the function of "cores," using the term in its broadest sense. Parenthetically, we may note that the term *core* strictly relates to something made apart from the mould, and inserted subsequently. It is usually dried, but not invariably; if not, it is often termed a *green sand core*. If a piece that fulfils the function of a core be rammed in the mould, it is termed a false core, or *drawback*.

The methods of making cores are broadly divisible under three heads. Since any internal body of sand, as distinguished from external portions, is a core, the first method is that in which internal portions are delivered from the pattern, or self-delivery. But in the greater number of cases the core is rammed in a box separate and distinct from the pattern. The box encloses its sand, and, therefore, as in patterns, provision must be made for the removal of the core from its box without sustaining damage. Hence most boxes are divided in one or more planes, and the same devices of taper and loose pieces must be embodied in many boxes, as in patterns when identical conditions of delivery arise. Examples of boxes are given in **37** and **52**.

Loam Cores. The third great class of cores comprises that in which sweeping up in wet loam is adopted, as in **34**. It is applicable to heavy circular work, and to *strickled* work. The object often is to save the expense of making a large core box, but there are many cases in massive work in which a core rammed in sand would not be practicable. The loam is plastic, and is swept on a skeleton built upon a revolving core bar, and afterwards dried. In strickled work loam is still swept around a skeleton-like framing, but instead of a revolving bar, a guide iron, or the edge of a core plate becomes the guide to the movements of the strickle.

Core Prints. As a core has to be made separately from its mould, it is usually necessary to make provision to ensure its exact setting in the mould. This is the function of *core prints*, the forms of which are varied to suit the direction in which the core has to be inserted, its mass, or area, and other conditions. Core prints are put in top and bottom of patterns and moulds, or at the sides. In the latter position they often take the form of *pocket*, or *drop prints*, to avoid having to make a sand joint down to the centre of the print. Then the upper part of the drop print is filled up with sand after the insertion of the core, or the core box is made of such a shape that the core shall fill it up, or *stop itself off*. Numerous examples of cores set vertically are given in the preceding figures of core prints, but some further remarks are desirable relating to those in the



35. Crosshead casting **36.** Pattern for No. 35 **37.** Core-box for No. 35 **38.** Mould for No. 35 **39.** Cylinder casting in section **40.** Section through pattern of No. 39 **41.** Section through mould of No. 39 **42.** Lathe-bed in section **43-45.** Alternative methods of making pattern for No. 42 **46.** Diagram to illustrate taper **47.** Taper in a loose piece **48.** Drop or pocket-print **49.** Core in impression of drop or pocket-prints **50.** Drop-prints superimposed **51.** Single-print thickness for two holes **52.** Core-box for ditto

horizontal position, which are carried in drop or pocket prints.

Drop Prints. Take the case of the lagged-up cylinder pattern, shown in section 48, with holes to be cored through the bolt bosses (A A) skewered on the inside of the foot, the drop prints being shown at B B. Looking at a section through one-half of the mould [49], a core (B) is made, and dropped into the mould. This core cannot be made of the full length (*a*) over print and boss, and dropped down into the mould through the narrower width (*b*). To put a pocket print on the same side as the boss would give trouble, which is avoided by making the prints B B [48] sufficiently thick to more than counterbalance the weight of their cores. Then, making the core B only of the length *b* in **49**, it is dropped down into position, and then slid along to touch the face of the boss, as shown, afterwards filling up the space *c* with sand to keep it from shifting.

Not infrequently it happens that two or more holes are required horizontally in a plate, one above another, as in **50**, which represents a pattern in side and end elevation, with the pocket prints for coring out the holes, the positions for which in the casting are indicated by dotted lines at *a a*. In such cases the prints are either superimposed (A B) or a single print is used, as in **51**, and a special core box made.

When two prints superimposed are used the outer one should be made a little thicker than the one which goes next the pattern, to afford sufficient guidance for the top core, which has to pass across a greater distance than the bottom core. This is indicated in **50**.

Fig. **52** shows a core box in plan, and opened in the joint face, for coring both holes with a single print.

Distinction Between Cores and Bosses. A natural question is, how is the moulder able to distinguish these core prints, which are not parts to be cast, from bosses, which have to be? Mistakes have often occurred in this way. Thus, a moulder not recognising the function of a roller in the pattern of **16**, might cast the prints *a* on if a core box were not sent him. He could not make such an error in **36**, having a core box, **37**. Frequently in large patterns, bosses and prints are numerous and look alike, and it is not usual to send boxes for plain cores. Error is prevented in shops where a good system exists by varnishing or painting prints differently from the body of the pattern. Generally, clear yellow shellac varnish is used for the patterns, and black for the core prints. This is often carried a stage further. Patterns for brass are distinguished from those for iron by varnishing the bodies black and the prints yellow.

It is often necessary to make moulds with certain portions lowermost, to ensure sound, clean metal in surfaces which have to be planed, or otherwise machined bright. Such faces are painted red, or other distinctive colour. The lathe-bed [42] is a case in point. These are always cast upside down, as indicated in **43** to **45**. Here the loose pieces render the method obvious. But often there is no distinctive feature of this kind to guide the moulder, hence the advantage of colouring red.

Shrinkage. One other matter calls for consideration here. All the common metals and alloys shrink as they cool down from the molten state. Unless the mould were made larger than the required dimensions of the casting when cold, the latter would be too small. So that all patterns are made of larger dimensions than their castings by this amount, and this, again, varies in quantity in iron, steel, brass, gun-metal, aluminium, and not only in the different metals, but in metal of the same name in different compositions, and under diverse conditions of casting.

The following table embodies averages for the common metals and alloys:

SHRINKAGES OF CASTINGS.

Cast iron, average $\frac{1}{8}$ in. in 15 in.; light castings, $\frac{1}{8}$ in. in 16 in.; heavy and mottled, $\frac{1}{8}$ in. per 12 in.; work mainly cored, $\frac{1}{8}$ in. per 12 in., or less.

Malleable cast iron, $\frac{3}{16}$ in to $\frac{1}{4}$ in. per 12 in.

Bronzes and brasses, $\frac{1}{8}$ in. to $\frac{1}{4}$ in. per 12 in., depending on composition and on mass.

Steels, $\frac{1}{8}$ in. to $\frac{1}{4}$ in. in 12 in. Heavy castings shrink most, light ones least.

Aluminium, $\frac{1}{4}$ in. in 12 in.

Copper, $\frac{3}{16}$ in. in 12 in.

Lead, $\frac{3}{16}$ in. to $\frac{5}{16}$ in. in 12 in., depending on its degree of purity.

Tin, $\frac{1}{8}$ in. in 12 in.

Patterns for Different Metals. A question that arises not infrequently in most shops is this: Castings are wanted off the same patterns at different times in iron and in steel; and in the smaller pinions, also in gun-metal or phosphor-bronze. As the shrinkage of these varies, the foreman who has to give orders for each in turn has to attempt to reconcile the irreconcilable. The difficulties have to be got over by these methods.

For standard work, where correct pitch diameters must be maintained, separate patterns must be made for cast iron and steel. But the latter will serve also for gun-metal and phosphor-bronze. In very small pinions not exceeding, say, 6 in. in diameter, the difference in shrinkage may be neglected, but over that size it becomes very marked. In fact, a heavy, solid pinion of 10 or 12 in. diameter will show a higher rate of shrinkage than a larger wheel with arms. For large steel wheels the moulding-machine offers advantages over pattern-moulded gears, especially when gears are shrouded.

An advantage of making a separate pattern, or a special set of pattern parts for machine moulding for steel, is that the sections can be lessened, steel being stronger than iron.

When exact centres are not important, then these steel wheels can be cast from patterns made for iron, and though the difference in diameter may amount to several eighths of an inch in a wheel of fair size, yet the pitch will be practically unaffected.

Continued

Continued from page 2196

SPANISH

Continued from page 2192

By Amalia de Alberti

NOUNS

Formation of the Plural. (1) Nouns ending with an unaccented vowel take an *s* in the plural, thus:

SINGULAR.	PLURAL.
carta, letter	*cartas*
madre, mother	*madres*
libro, book	*libros*
espiritu, spirit	*espiritus*

(2) Nouns ending in *é* also take *s* in the plural:

pié, foot	*piés*
café, coffee	*cafés*
té, tea	*tés*

(3) Nouns ending in an accented vowel take *es* in the plural:

bajá, pasha	*bajáes*
rubí, ruby	*rubíes*
tisú, tissue	*tisúes*

Exceptions to this rule are *papa, mama, sofa*, which take *s* only; pl., *papas, mamas, sofas*.

(4) Nouns ending in a consonant also take *es* in the plural:

verdad, truth	*verdades*
dolor, grief	*dolores*
razon, reason	*razones*
rey, king	*reyes*

(5) Nouns ending in *z* convert *z* into *ces* in the plural:

voz, voice	*voces*
juez, judge	*jueces*
pez, fish	*peces*

(6) Polysyllabic words unaccented on the last syllable, and surnames ending in *s* and *z* are invariable in the plural:

lunes, Monday	*los lunes*
crísis, crisis	*las crísis*
Valdés (a surname)	*los Valdés*
Fernandez (a surname)	*los Fernandez*

(7) Some Spanish plurals may include the feminine, ex.:

los reyes, the kings, or the king and queen.

los amos, the masters, or the master and mistress.

los abuelos, the grandfathers, or the grandparents.

los padres, the fathers, or the parents.

Genders. The gender of nouns is determined by their signification or termination.

As a general rule the ending *a* denotes the feminine gender, and *o* the masculine, as: *el macho*, the male; *la hembra*, the female.

The following nouns are masculine by signification:

(1) All names of men or male animals and of dignities, professions, and callings peculiar to men,

soldado, soldier	*toro*, bull
cura, curate	*perro*, dog
albañil, mason	*caballo*, horse

(2) The names of countries, cities, and towns are generally masculine, except those ending in *a*.

(3) All rivers are masculine except the Huerva, which is feminine, and the Esqueva, to which both genders are applied.

The following nouns are feminine by signification:

(1) All names of women or female animals and of dignities, professions, and employments usually assigned to women:

lavandera, washerwoman	*vaca*, cow
cocinera, cook	*gallina*, hen
costurera, seamstress	*yegua*, mare

(2) The names of arts and sciences, except those ending in *o*, as: *la escultura*, sculpture; *la geometria*, geometry.

(3) The names of virtues, as: *la fé*, faith; *la constancia*, constancy.

Masculine by termination: Nearly all nouns ending in *e, i, o, u, j, l, n, r, s, t*.

Feminine by termination: Nearly all nouns ending in *a, d, z, is, en, ion, ente, be, re, bre, erte*.

The exceptions to these general rules can only be learnt by practice.

Some nouns are used in both genders, as: *mar*, the sea, which is either masculine or feminine; but all its derivatives are feminine; as: *la bajamar*, low tide; *la pleamar*, high tide. *Arte*, art, is always feminine in the plural and sometimes masculine in the singular, as: *las bellas artes*, the fine arts; *el arte dramático*, dramatic art.

Some nouns have a different meaning, according to their gender:

el cometa, comet	*la cometa*, child's kite
el corte, cut	*la corte*, court
el moral, mulberry tree	*la moral*, morals
el cólera, cholera	*la cólera*, anger
el papa, pope	*la papa*, potato
el pendiente, pendant	*la pendiente*, slope
el pez, fish	*la pez*, pitch

Formation of the Feminine. Most masculine nouns may be made feminine as follows:

By changing final *o* or *e* into *a*, as: *hermano*, brother; *hermana*, sister; *monje*, monk; *monja*, nun.

By adding *a* to the masculine, as: *marques*, marquis; *marquesa*, marchioness.

A few nouns ending in *or* change their ending to *triz* in the feminine, as: *actor*, actor; *actriz*, actress; *emperador*, emperor; *emperatriz*, empress.

Some form the feminine by adding *esa* to the masculine, as: *abad*, abbot; *abadesa*, abbess; *conde*, count; *condesa*, countess.

A few change their termination into *isa*, as: *poeta*, poet; *poetisa*, poetess; *profeta*, prophet; *profetisa*, prophetess; *diácono*, deacon; *diaconisa*, deaconess.

Vocabulary		Vocabulario	
The head	La cabeza	To walk	Andar
The eyes	Los ojos	To run	Correr
The nose	La nariz	To work	Trabajar
The mouth	La boca	To rest	Descansar
The teeth	Los dientes	To swallow	Tragar
The ears	Las orejas	To devour	Devorar
The arms	Los brazos	A dog	Un perro
The hands	Las manos	A cat	Un gato
The nails	Las uñas	A parrot	Un loro
A scratch	Una uñada	A canary	Un canario
The feet	Los piés	A monkey	Un mono
A kick	Una patada	A monkey (fem.)	Una mona
Toe nails	Las uñas de los piés	A dining-room	Un comedor
To go for a walk	Ir de paseo	A side-board	Un aparador
Drink	Beber	A table	Una mesa
To eat	Comer	The chairs	Las sillas
To sing	Cantar	A sofa	Un sofá
To talk	Hablar		

An armchair	Un sillon
A small triangular table	Una rinconera
The carpet	La alfombra
The dining-room clock	El reloj del comedor
The frames	Los cuadros
The pictures	Las pinturas
The engravings	Los grabados
The piano	El piano
To play the piano	Tocar el piano
To play the violin	Tocar el violin
To play the harp	Tocar el arpa
To play the violoncello	Tocar el violoncelo
The kitchen	La cocina
The kitchen table	La mesa de la cocina
The kitchen fire	El fuego de la cocina
The stove	La hornilla
The oven	El horno
The man cook	El cocinero
The cook	La cocinera
The scullion	El pinche
The butcher	El carnicero
The baker	El panadero
The greengrocer	El verdulero
The grocer	El especiero
The water carrier	El aguador
The dustman	El basurero
To cook	Guisar
The servant	El criado
The servant (fem.)	La criada
The lady's maid	La doncella
The valet	El lacayo
The porter	El portero
The country house	La casa de campo
The smell	El olor
A smell	Un olor

The taste	El gusto
The sight	La vista
A view	Una vista
The touch	El tocar
To touch	Tocar
A blind man	Un ciego
A blind woman	Una ciega
A deaf man	Un sordo
A deaf woman	Una sorda
A deaf mute	Un sordo mudo
A giant	Un gigante
A dwarf	Un enano
A dwarf (fem.)	Una enana
An orphan	Un huérfano
An orphan (fem.)	Una huérfana
Twins	Unos mellizos
Twins (fem.)	Unas mellizas
The law	La ley
A judge	Un juez
A magistrate	Un magistrado
Advocate	Un abogado
A notary	Un notario
To appeal	Apelar
A law-suit, a case	Un pleito
To plead, to litigate	Pleitear
To lose a law-suit	Perder un pleito
To win a law-suit	Ganar un pleito
To pay the costs	Pagar las costas

Exercise III.

Translate the following into Spanish:

1. The comet shines at night. 2. The children
. . . . luce de . . . .
fly the kites. 3. The cholera is dangerous.
vuelan . . . . peligroso.
4. Anger is a sin. 5. The cut of this dress is
. . . . pecado . . . . este traje . .
good. 6. The Court of St. James's. 7. The
. . . . St. James . . . .
mulberry-tree has a lot [of] fruit. 8. The
. . . . mucha . . . .
morals of nations differ. 9. The pendant is of
. . . . difieren . . . .
diamonds. 10. The declivity of this hill is
brillantes . . . . esta cuesta . .
great. 11. One bows with the head. 12. The
. . . . Se saluda con . . . .
eyes are for seeing and the nose for smelling.
. . . . ver . . . . oler.
13. The mouth is for eating and the teeth for
. . . .
chewing. 14. The hands are for touching, and
masticar . . . .
the nails for scratching. 15. The feet are for
. . . . arañar . . . .
walking. 16. To go for a walk. 17. The dog
. . . .
fights with the cat. 18. The chairs of the
se pelea con . . . .
dining-room are green. 19. The butcher brought
. . . . trajo
the meat and the baker the bread. 20. The
. . . .
cook cooks well. 21. The porter opens the door
. . . guisa . . . . abre . . . . . .
of the house. 22. The judge judges the case
. . . . juzga . . . . . .

and the lawyer defends it. 23. The magistrate
. . . . lo defiende . . . .
administers justice. 24. To plead is costly.
administra . . . . costoso.
25. One can appeal when one loses a law-suit.
. . Se puede . . . cuando se pierde . . . . . .

NOTE. For the verbs eating, touching, etc., use the infinitive.

PROSE EXTRACT III.

From the "Historia General de España," by Juan de Mariana.

THE DEATH OF KING RODERICK.

The Goths advanced to the sound of their drums and trumpets; the Moors beat to battle with their metal kettledrums, according to their fashion. Loud was the clamour on both sides, until the mountains and valleys seemed to meet.

At first they fought with slings, darts, all sorts of arrows, and lances; then they began with swords. The battle was very fierce, for one side fought as conquerors, and the other as determined to conquer.

The victory was doubtful for the best part of the day, though the Moors gave signs of yielding and seemed disposed to slacken, and even to retreat. Then—oh, incredible wickedness!—Don Oppas, who had hitherto concealed his treason, suddenly went over to the enemy with a good number of his followers in the greatest heat of the battle, as he had planned in secret.

He joined Don Julian, who was followed by a great number of Goths, and together they attacked our weakest flank. Our men, astounded at such treachery, and tired out with fighting, could not endure this fresh attack, and were easily broken and put to flight, though the king with his most valiant followers fought in the van, helping in every direction, succouring those who were in danger, replacing the dead and wounded with fresh men, and even arresting the fugitives with his own hands. Thus he played the part both of a good captain and a brave soldier.

At last, all hope of victory being lost, to escape falling alive into the hands of the enemy, he leapt from his chariot, mounted a horse called *Orelia*, which he had with him in case of such emergency, and withdrew from the field.

Bereft of his help, the Goths, who were still fighting, lost heart; some were left dead on the field, the rest took to flight, and the tents and baggage were taken in a moment.

The number of the dead is not stated, I suppose because they were so many that they could not be counted, for, verily, by this battle alone Spain was despoiled of all her courage and glory. Fatal day—day of tears and sorrow! There fell the glorious name of the Goths, their martial might, their fame of ancient times! There ended the hope of posterity, and the empire which had endured for more than three hundred years was overthrown by a fierce and cruel nation.

Don Roderick's horse, his surcoat, crown, and buskins, embroidered in pearls and jewels, were found on the bank of the river Guadalete, and as no other trace of him was

LA MUERTE DEL REY DON RODRIGO.

Los godos al son de sus trompetas y cajas se adelantaron, los moros al son de los atabales de metal á su manera encendian la pelea; fue grande la gritería de la una parte y de la otra; parecia hundirse montes y valles.

Primero con hondas, dardos y todo genero de saetas y lanzas se comenzó la pelea; despues vinieron á las espadas; la pelea fué muy brava porque los unos peleában como vencedores; y los otros por vencer.

La victoria estuvo dudosa hasta gran parte del dia sin declararse; solo los moros daban alguna muestra de flaqueza, y parecia querian ciar y aun volver las espaldas, cuando Don Oppas! oh incredible maldad! disimulada harta entonces la traicion, en lo mas recio de la pelea, segun que de secreto lo tenia concertado, con un buen golpe de los suyos se pasó á los enemigos.

Juntosé con don Julian, que tenia consigo gran número de los godos, y de través por el costado mas flaco acometió á los nuestros. Ellos, atónitos con traicion tan grande y por estar cansados de pelear, no pudieron sufrir aquel nuevo impetu, y sin dificultad fueron rotos y puestos en huida, no obstante que el rey con los mas esforzados peleaba entre los primeros y acudia á todas partes, socorria á los que veia en peligro, en lugar de los heridos y muertos ponia otros sanos, detenia a los que huian a veces con su misma mano; de suerte que no solo hacía las partes de un buen capitan, sino tambien de valeroso soldado.

Pero al último, perdida la esperanza de vencer, y por no venir vivo en poder de los enemigos, saltó del carro y subió en un caballo llamado Orelia, que llevaba de respeto para lo que pudiese suceder; con tanto él se salió de la batalla.

Los godos que todavía continuaban la pelea, quitada esta ayuda, se desanimaron, parte quedaron en el campo muertos, los demas se pusieron en huida; los reales y el bagaje en un momento fueron tomados.

El numero de los muertos no se dice; entiendo yo que por ser tantos no se pudieron contar; que a la verdad esta sola batalla despojó á España de todo su arreo y valor. Dia aciago, jornada triste y llorosa. Alli pereció el nombre ínclito de los godos, alli el esfuerzo militar, alli la fama del tiempo pasada, alli la esperanza del venidero se acabaron, y el imperio que mas de trescientos años habia durado quedó abatido por esta gente feroz y cruel.

El caballo del rey don Rodrigo, su sobreveste, corona y calzado, sembrado de perlas y pedreria, fueron hallados á la ribera del rio Guadalete, y como quier que no se hall-

found it was supposed that he was killed in his flight, or was drowned in crossing the river.

It is true that 200 years later a stone was found in a church in the city of Viseo, in Portugal, with a Latin inscription, which, translated into the Romance language, is as follows:

Here lies Roderick, the last king of the Goths.

From this it is supposed that after the battle he fled to Portugal.

———

Juan de Mariana (1536-1623) is the most celebrated historian of Spain. His "Historia General de España" was the first general history of that country ever written. It begins with the supposed peopling of Spain by Tubal, son of Japhet, and comes down to the

asen algunos otros rastros de él se entiende que en la huida murió ó se ahogó á la pasada del rio.

Verdad es que como doscientos años adelante en cierto templo de Portugal, en la cuidad de Viseo se halló una piedra con un letrero en latin, que vuelto en romance dice:

Aqui reposa Rodrigo, ultimo rey de los Godos.

Por donde se entiende que salido de la batalla, huyó á las partes de Portugal.

———

Juan de Mariana (1536-1623) el mas célebre historiador de España. Su "Historia general de España" fué la primera que se escribió. Empieza con la supuesta problacion de España por Tubal, hijo de Japhet, hasta la ascencion de Carlos V. La fama de Mari-

accession of Charles V. The fame of Mariana rests rather on the beauty of his prose than on his historical accuracy.

ana resta mas en la belleza de su prosa, que en su exactitud historica.

Key to Exercise II.

1. El oro y la plata son considerados como los más preciosos metales.
2. Las minas de cobre son á veces de más provecho que las de oro y plata.
3. El fuego como elemento es devastador.
4. El aire es fresco.
5. La lluvia aplaca el viento.
6. La noche es para descansar
7. El dia es para trabajar.
8. Pescamos en el río.
9. En el jardin hay flores.
10. En el huerto hay frutas.
11. Las flores del campo son artisticas.
12. *El* mar del Norte es tempestuoso.
13. *La* mar es plácida.
14. *El* alma es inmortal.
15. *Las* almas de los justos descánsan en el Señor.
16. *El* hada benéfica.
17. *Las* hadas malévolas.
18. Enterrar *el* hacha es señal de paz entre los indios.
19. Se usaban *las* hachas como armas de defensa.
20. Echar *el* ancla.
21. *Las* anclas de los navíos.

Continued

ITALIAN

Continued from page 2194

By Francesco de Feo

PLURAL OF NOUNS

General Rule. (*a*) All masculine nouns ending either in *o* or *a*, and all masculine, feminine, and common gender nouns ending in *e* (not preceded by an *i*), form the plural by changing the *o*, *a*, *e* into *i*. Thus: *il quadro* (the picture), *i quadri; il poeta* (the poet), *i poeti; il lume* (the lamp), *i lumi; la lezione* (the lesson), *le lezioni; l'abitante* (the inhabitant), *gli abitanti; il parente, i parenti*, etc. The feminine *mano* (hand) makes its plural regularly: *le mani.*

(*b*) All feminine nouns in *a* form the plural by changing the *a* into *e*, as: *la chiesa* (the church), *le chiese; la casa, le case; la carrozza, le carrozze.*

(*c*) All nouns ending in *i*, *ie*, except *moglie* (wife), *mogli;* all those ending in an accented vowel, monosyllabic nouns, and the very few ending in a *consonant* do not change in the plural. Ex.: *Il brindisi, i brindisi; la specie* (species, kind), *le specie; la città, le città; la povertà* (poverty), *le povertà; la servitù* (servitude, the servants), *le servitù; il re, i re; il lapis* (pencil), *i lapis.*

Compound Nouns. The compound nouns usually follow the general rule given above, as *passatempo* (pastime), *passatempi; mezzogiorno* (midday), *mezzogiorni; madreperla* (mother-of-pearl), *medreperle; lavamano* (washstand), *lavamani.* Observe, however, that:

(*a*) Some change both parts in the plural—*e.g.*, *capoluogo* (principal place), *capiluoghi; capocomico* (leading actor), *capicomici; bonamano* (gratuity), *bonemane*, etc.

(*b*) Some change the first part only—*e.g.*, *capofàbbrica* (manager), *capifabbrica; capocaccia* (chief huntsman), *capicaccia*, etc.

(*c*) Some have the same form in the singular and in the plural, as: *il salvagente* (life saver), *i salvagente; il portabandiera* (the standard bearer), *i portabandiera*, etc.

The plural of such nouns will always be given.

Vocabulary

nostro, our
vostro, your
àbito, coat, dress
sporco (fem. pl. *sporche*), dirty
settimana, week
ogni, every
terremoto, earthquake
tetto, roof, house
bottiglia, bottle
ufficiale, officer
pranzo, dinner
flotta, fleet
sordomuto, deaf and dumb
indirizzo, address
cavatappi, corkscrew
raccolto, gathered, collected
andare, to go
andato, gone
danneggiato, damaged
dato, given
aperto, opened
perchè, why, because

EXERCISE IX.

Nel nostro giardino abbiamo frutti e fiori. I ragazzi hanno raccolto dei fiori per i forestieri e hanno avuto del danaro. Gli abiti delle signore sono nel guardaroba. Le vostre mani sono sporche. I lavoratori avranno la paga ogni settimana. I lumi sono su la tavola. Nelle scuole, nelle chiese nei teatri hanno raccolto danari per i danneggiati dal terremoto. Gli abitanti sono senza (without) tetto. I soldati ebbero ordine di andare nelle città danneggiate. Vi sono molte vittime. Gli scolari avranno carta, lapis e penne. Gli ufficiali hanno dato un pranzo in onore della flotta inglese; vi sono stati molti brindisi. Hanno aperto una scuola per i sordomuti. Abbiamo molte bottiglie di vino, ma non abbiamo un cavatappi. Non abbiamo scritto le lettere, perchè non abbiamo trovato gl'indirizzi. Quando avrete scritto le risposte sarete liberi (free) di andare.

CONVERSAZIONE.

Ragazze, dove siete state domenica ?

Siamo state al giardino zoologico, dove abbiamo veduto (seen) leoni, leonesse, tigri, lupi e molti altri (many other) animali.

Dove avete raccolto tanti (so many) fiori ?

Nel giardino di nostra zia; essi sono per le mogli degli ufficiali.

Perchè non siete andate a teatro ?

Perchè quando abbiamo ricevuto i biglietti (tickets) era già molto tardi (very late).

Quando saranno a Parigi i vostri amici ?

Essi saranno a Parigi domenica e saranno a Londra la settimana prossima (next).

Chi (who) ha comprato questi (these) portasigari ?

Il padrone ha comprato due (two) portasigari e un portabiglietti per i servitori.

Vi sono lettere per me ?

No, signore; ma vi sono due telegrammi per la signora. La signora è andata all' esposizione con le sorelle e le nipoti del signor Dottore e sarà in casa alle due e mezzo (at half past two).

IRREGULARITIES IN THE PLURAL OF NOUNS.

1. *Uomo*, man, *uòmini*, men (*cf.* the Latin *homo*, *homines*); *ala* (fem.), wing, *ali*, wings—but: *le ale d'un esercito; dio*, god, *dei*, gods; *bue*, ox, *buoi*, oxen; *mille* (*meèlleh*), thousand, *mila*, thousands.

2. The following words in the plural end in *a*, and become feminine:

Centinaio (*chehntee-nàh-eeo*), a hundred, *le centinaia; migliaio* (*mee-lee-àh-eeo*), a thousand, *le migliaia; miglio* (*meè-lee-o*), mile, *le miglia; paio* (*pàh-eeo*) pair, *le paia; uovo* (*oo-òvo*) egg, *le uova, le ova; riso* (*reèso*), laughter, *le risa*.

3. *Brio* (*breèo*), vivacity, and *la prole* (*pròleh*), offspring, are used in the singular only.

Le esequie (*ehsèh-koo-ee-eh*), funeral, *le forbici* (*fòrbee-chee*), scissors, *le nozze* (*nòtseh*), wedding, *gli occhiali* (*ockee-àhlee*), spectacles, and a very few more nouns, are used in the plural only.

4. Some nouns change their signification in the plural, as: *genitore* (father), *genitori* (parents); *gente* (*dgènteh*), people, *genti* (men, nations); *misura* (*meesoòrah*), measure, *misure* (dispositions, also measures); *gràzia* (*gràtseeah*), grace, *grazie* (thanks, also graces).

5. Some words in *o* have a double plural, often with different meanings.

The commonest are:

Bràccio (arm), *le braccia* (of the human body); *i bracci* (figuratively) as: *i bracci della sedia* (the arms of the chair).

Dito (finger), *le dita* (speaking of all the fingers), as: *le dita della mano; i diti* (specifying the fingers), as: *i diti mignoli* (the little fingers).

Frutto (fruit), *le frutta* (dessert); *i frutti* (income, profit), as: *i frutti dello studio* (study); *i frutti del capitale*.

Labbro (lip), *le labbra* (speaking of the human body); *i labbri* (figuratively), as: *i labbri d'una ferita* (wound).

Legno (wood), *le legna* (firewood); *i legni* (wood, ships).

Membro (limb), *le membra* (of the body and figuratively); *i membri* (figuratively, members of a society), as: *i membri del Parlamento*.

Muro (wall), *le mura* (speaking of a fortress, or of the walls of a city, or of a house as a whole); *i muri* (walls in general).

Osso (bone), *le ossa* (of the body); *gli ossi* (bones in general).

Pronounced: *bràcchee-o, deèto, froòtto, làhbbro, lèhneeo, mèhmbro, moòro, osso.*

Vocabulary

destra (*dèh-strah*), right	*pane* (*pàhneh*), bread
sinistra (*see-neè-strah*), left	*argento* (*ahr-dgèhn-to*), silver
freddo (*frèhddo*), cold	*dieci* (*dee-èh-chee*), ten
caldo (*kàhldo*), hot	*parècchie* (*pahrèh-kee-eh*), several
brìvido (*breè-veedo*), chill	*comprato*, bought
carro (*cahrro*), waggon, cart	*portato*, brought
morte (*mòrteh*), death	*là, lì* (*lah, lee*), there
aver freddo, to be cold	*aver caldo*, to be warm
aver fame, to be hungry	*aver sete*, to be thirsty

EXERCISE X.

1. La mano ha cinque dita. 2. Le risa dei ragazzi. 3. Un carro tirato (drawn) da due paia di buoi. 4. Le due ale di destra dell'esèrcito nemico erano ciascuna di dieci mila uòmini. 5. Questa sera avremo freddo, perchè non abbiamo legna in casa. 6. Abbiamo comprato delle uova e del pane perchè abbiamo fame. 7 Ho molto freddo; ho i brividi nelle ossa. 8. Dove sono le fòrbici ? Sono lì, sulla tàvola, insieme con gli occhiali. 9. I contadini hanno portato frutti e fiori per le nozze d'argento dei padroni. 10. Alla morte della zia, quella ragazza avrà parècchie miglìaia l'anno.

KEY TO EXERCISE VII.

The King and the Queen are at Windsor. The Emperor and the Empress of Russia will go to France [in] the month of August. The wife of the guard is a hard working woman. The Alpinists and the guides have lost themselves in the Alps. The ox, the cow, the she-goat, the hen are animals useful to man. The lioness and the tigress are more ferocious than the lion and the tiger. Louis's sister has two children, a boy

and a girl. The grape and the date are the fruit of the vine and the palm-tree. The brother and niece of the baroness have the intention of going to Paris. A multitude of boys and girls are in the country with the mistress and the landlady. The son-in-law of the doctor is an artist and the sister is a pianist. The daughter of the physician is a doctor of literature and also a poetess and a painter; she is authoress of a poem and [painter] of a picture, which is at the Berlin Exhibition.

KEY TO EXERCISE VIII.

He has. He has not. Has he? Has he not? They had. They had not. Had they not? Have they not had? No, but they will have. When will they have? When they shall have been. Have they not been? They were, but we had already been. Will you not have had? Will you not have been? Shall we not have? You will have when you shall be; they will have, when they shall have been. Have they had? Will they not have? Had you? Had you? Were they? Are they? They are not, but they will be, when they will have had.

Note that the past participle, preceded by the verb *èssere*, always agrees both in gender and number with the subject of the sentence. Ex.: Egli è stat*o*, essa (she) è stat*a*, essi sono stat*i*, esse sono stat*e*; egli è andat*o* (gone), essa è andat*a*, essi sono andat*i*, esse sono andat*e*.

Continued

FRENCH

Continued from page 2196

By Louis A. Barbé, B.A.

INDEFINITE PRONOUNS

The indefinite pronouns (*pronoms indéfinis*) are: *On, quiconque, quelqu'un, quelque chose, personne, rien, chacun, autrui, l'un l'autre, l'un et l'autre.*

1. *On*, one, they, people. *On* is very widely used in French. It is always the subject of a verb in the third person singular. It may be translated literally by "one," and occasionally by "some one":

(*a*) *On doit obéir aux lois,*
One must obey the laws.

(*b*) *On nous a indiqué le chemin,*
Someone showed us the road.

When (as in *a*) *on* has a collective meaning, and includes the speaker, it may be rendered by "we": "We must obey the laws." When it is collective, but does not include the speaker, *on* may be translated by "people," or by "they":

On craint ce roi et on lui obéit, mais on ne l'aime pas, People fear that king and obey him, but they do not love him.

Very often an English passive construction supplies the best rendering of a French sentence that has *on* for its subject: "That king is feared and obeyed, but he is not loved."

When *on* is preceded by *si*, if; *ou*, or; *où*, where; *que*, whom, that; *qui*, who, and *et* in which the final *t* is silent, it usually takes *l'* before it, to avoid the hiatus caused by two vowel sounds:

On n'aime pas à voir ceux à qui l'on doit tant,
We do not like to see those to whom we owe so much.

This *l'* must not be used when the word coming after *on* begins with *l'*:

On l'admire et on l'aime, He is admired and loved.

On must be repeated before every verb of which it is the subject:

On le loue, on le menace, on le caresse,
They praise, threaten, caress him.

2. *Quiconque*, whoever, is always followed by a singular verb:

Quiconque est riche, est tout,
Whoever is rich, is everything.

Words in agreement with either *on* or *quiconque* may be feminine if the sense absolutely requires it:

Quand on est mère on ne doit pas être coquette,
When one is a mother, one should not be a coquette;

Quiconque est vraiment mère n'est plus coquette,
Whoever is a real mother is no longer a coquette.

3. *Quelqu'un* has two different meanings, according as it is used absolutely—that is, without reference to a noun, or relatively, that is, with reference to a noun.

When *quelqu'un* is used absolutely it means "someone," "anyone," and applies to persons only:

Quelqu'un a dit que le soleil est l'âme du monde,
Someone has said that the sun is the soul of the world.

Quelqu'un doute-t-il sérieusement de l'existence de Dieu? Does anyone seriously doubt the existence of God?

When *quelqu'un* is used relatively, it applies to both persons and things, and means "some," "any," "a few." It is then used chiefly in the plural, and has either *de* and a noun after it, or *en* before the verb if the noun is understood:

Connaissez-vous quelques-unes de ces dames? Do you know any of those ladies?

J'en connais quelques-unes, I know a few of them.

Avez-vous encore de ces livres? Have you any more of those books?

J'en ai encore quelques-uns, I still have a few.

Quelqu'un, quelqu'une, quelques-uns, quelques-unes, require *de* before an adjective qualifying them:

Je connais quelqu'un de plus riche que lui,
I know someone richer than he.

4. *Quelque chose*, as an indefinite pronominal expression, requires words in agreement with it to be masculine, and adjectives qualifying it to be accompanied by *de*. It has the meaning of "something," "anything":

Il y a dans ce livre quelque chose d'incomplet.
There is something incomplete in that book.

Autre chose, something else, anything else, and *grand'chose,* much, are used in the same way, and follow the same rule as *quelque chose :*

Avez-vous autre chose de curieux à nous montrer?
Have you anything else curious to show us ?
Il n'a pas fait grand'chose de bon,
He has not done much that was any good.

5. *Personne,* when joined to *ne,* is negative, and means no one. It is used without *ne,* and with the meaning of "anyone" in interrogative sentences, or in sentences expressing doubt. Words in agreement with it are masculine, and adjectives qualifying it are preceded by *de :*

Il n'y a personne d'assez hardi,
There is nobody bold enough.
Y a-t-il personne d'assez hardi ?
Is there any one bold enough ?

6. *Rien* is negative, and means "nothing," when it is accompanied by *ne.* It may be used without *ne,* and with the meaning of "anything" in interrogative sentences, or in sentences expressing doubt. Adjectives qualifying it take *de :*

Il n'y a rien de nouveau, There is nothing new.
Y a-t-il rien de plus désagréable ?
Is there anything more disagreeable ?

7. *Chacun,* like *quelqu'un,* may be used either absolutely or relatively. In the former case, it applies to persons only, and has no feminine form. It means "each one" :

Chacun croit avoir assez de sens commun, Each one thinks he has enough common-sense. When used relatively, it applies to both persons and things, and has a feminine form, *chacune :*

Ces gravures me coûtent cinquante francs chacune,
Those engravings cost me fifty francs each.
Chacun de ses enfants a remporté un prix,
Each of his children has carried off a prize.

8. *Autrui,* though rendered by the English, "others," is always singular. It may not be used as a subject, and only occurs in connection with *à* or *de :*

Attendez d'autrui ce que vous faites à autrui,
Expect from others what you do unto others.

9. *L'un l'autre,* one another, each other, has the feminine form *l'une l'autre,* and the plural forms *les uns les autres, les unes les autres.* In a sentence, the first part of this expression is always the subject, and the second part the object of the verb. Consequently, only the second part can have a preposition before it :

Ils médisent l'un de l'autre,
They speak evil of one another.
Les vrais chrétiens se pardonnent les uns aux autres,
True Christians forgive each other.

10. *L'un et l'autre* and its feminine form *l'une et l'autre* mean "both." When used with a personal pronoun, they cannot come immediately after it :

Ils rapportent l'un et l'autre les mêmes circonstances,
They both relate the same circumstances.

The plural forms *les uns et les autres, les unes et les autres* have no nearer English equivalent than "all" :

Ils se réunissent les uns et les autres contre l'ennemi commun, They all unite against the common enemy.

Exercise XVIII.

1. Where can (*peut*) one be better than in the bosom (*au sein*) of one's (*sa*) family (*famille*) ?
2. We have been told to (*de*) give you this.
3. They obey (to) that king because (*parce que*) they fear him, but nobody loves him.
4. He is said to be very rich.
5. Whoever has done that is a bad man.
6. If anyone speaks to you answer (*répondez*) him (to him).
7. I know no one here, and no one knows me.
8. If you have any more (*encore*) of those pears, give me a few.
9. Someone asks to (*à*) speak to you.
10. We have learnt (*appris*) something very interesting.
11. I know someone more powerful (*puissant*) than he.
12. We have not done much good to-day.
13. There is nothing more pleasant than travelling on foot (*de voyager à pied*).
14. Is there anything more surprising than this story ?
15. Each of my friends has carried off two or three prizes.
16. Do (*faites*) unto others what you would like (*voudriez*) that others should do (*fît*) to you.
17. I have spoken to both.
18. True Christians do not speak ill of one another.

Key to Exercise XVII.

1. Cette plume (-ci) est bonne, mais celle-là est meilleure.
2. Elle m'a montré son chapeau et celui de sa sœur.
3. J'aime mieux les nôtres que les leurs.
4. Si ce n'est pas lui c'est son frère.
5. Qui sont ces demoiselles ? Ce sont nos cousines.
6. Ce monsieur est-il avocat ? Non ; il est médecin.
7. C'est un de nos médecins les plus distingués.
8. Je ne connais pas ce monsieur ; je l'ai vu une ou deux fois, c'est vrai, mais je ne lui ai jamais parlé.
9. Il est vrai que nous ne lui avons jamais parlé, mais nous le connaissons très bien de vue.
10. Avez-vous fait cela ? Non ; ce n'est pas moi, c'est lui.
11. Si vous avez de plus belles gravures montrez-les-moi, je n'aime pas celles-ci.
12. Ce que vous venez de lire est très intéressant, mais ce n'est pas vrai.
13. Cette chambre-ci est plus petite que la nôtre, c'est la plus petite de toute la maison.
14. Donnez-moi un autre mouchoir, s'il vous plaît, j'ai perdu le mien.
15. Nos fleurs sont belles, celles de votre sœur sont encore plus belles, mais les vôtres sont les plus belles.
16. Cette bague n'est pas à moi, je n'en ai pas, elle est à une de mes amies.
17. Ce n'est pas sa bague, à elle, qu'elle a perdue, c'est la mienne.
18. À qui est-ce de jouer ? C'est à vous.

Continued

GERMAN

Continued from page 2052

By P. G. Konody and Dr. Osten

XXXIV. Substantives only used in the Singular. Many *abstract* nouns which, being in themselves collective and synthetic terms, have no plural, as: die Furcht, fear, terror; der Neid, envy; der Glanz, splendour; der Geiz, avarice; die Jugend, youth; die Unschuld, innocence, etc.; such *concrete* nouns, as: der Sand, the sand; der Schnee, the snow, etc.; and all nouns that are not substantives, but are used substantively, as: das Tanzen, the dancing; das Außeror'dentliche, the extraordinary. The concrete *effects* of abstract ideas and actions form a plural either in the ordinary way, or by circumlocution: die Dumm'heit (*s.*), stupidity; die Dummheiten (*pl.*), acts of stupidity, foolishness; das Glück (*s.*), luck, fortune; die Glücksfälle (*pl.*), strokes of luck; das Un'glück (*s.*), misfortune; die Un'glücksfälle (*pl.*), strokes of misfortune; der Betrug' (*s.*), fraud; die Betrügerei'en (*pl.*), fraudulent acts; der Dank (*s.*), thanks; die Dank'bezei'gungen (*pl.*), expressions of thanks.

1. The names of materials have as a rule no plural, but where different *kinds* of one material are concerned a plural can be formed, for instance: das Holz, (*s.*), wood, die Hölzer (*pl.*), different sorts of woods; das Geld (*s.*), money, die Gelder (*pl.*), the sums; das Gras (*s.*), grass, die Gräser (*pl.*), the grasses; das Getrei'de (*s.*), cereals, die Getrei'dearten (*pl.*), the different kinds of cereals; das Korn (*s.*), corn, die Körner (*pl.*), the grains.

2. Some collective nouns are only used in the plural: die El'tern, the parents; die Geschwi'ster, German collective for brothers and sisters; die Gebrüder, brothers (when defining a business firm: Gebrüder Hope, Hope Brothers); die Leute, folk, people; die Ostern, Easter; die Pfingsten, Whitsuntide; die Fasten, fasting, Lent; die Fe'rien, the vacation, holidays; die Blattern, smallpox; die Ma'sern, measles; die Zinsen, interest (on capital), etc. Collective nouns denoting mountain ranges: die Alpen, the Alps; die Anden, the Andes; die Cordilleren, the Cordilleras; die Voge'sen, the Vosges; but der Jura (*s.*), der Harz (*s.*), der Balkan (*s.*).

XXXV. The Demonstrative Pronouns are: der (*m.*), die (*f.*), das (*n.*), that (not to be confounded with the definite article der, die, das); dieser, this; jener, that; solcher, such, *or* such a; derjenige, he, *or* that; derselbe, the same; (the two last being compounds of der and jenige, and der and selbe), each with three genders and one plural form.

The declension of the demonstrative pronoun der, die, das, differs only in the variation of the genitive and dative from that of the definite article.

	Singular		*Plural*	
nom.	der, die, das,	that	die	those
gen.	des (dessen), der (deren), des (dessen),	of that	der (deren, also derer),	of those
dat.	dem, der, dem,	to that	den (denen),	to those
acc.	den, die, das,	that	die	those

1. The alternative genitive and dative form (dessen, deren, denen) is employed when the pronoun is used substantively: Die Blätter der Eiche unterscheiden sich von denen der Pappel, The leaves of the oak differ from those of the poplar. Obgleich England nicht so viele Soldaten hat als Deutschland oder Frankreich, hat es deren genug, um seine Kolonien zu verteidigen, Although England has not as many soldiers as Germany or France, it has enough [of them] to defend its colonies.

(*a*) Dessen and deren are also used as substitutes for the possessive pronouns sein, his, and ihr, her, to avoid ambiguity. Example: der Vater erzählte von seinem Freunde und seiner Reise, The father spoke of his friend and of his journey. It is not clear whether the journey is that of the father or that of the friend; if the latter, dessen must be substituted for seiner: der Vater erzählte von seinem Freunde und von dessen Reise.

(*b*) The alternative plural genitive derer is only used when followed by the relative pronoun welcher and der (who, which): Das Him'melreich ist derer, welche (die) Gott vertrauen, The Kingdom of Heaven is of those [belongs to those] who trust in God.

2. Dieser, diese, dies (or dieses), this; and jener, jene, jenes, that, follow the strong declension of the adjective [see XXVI.].

3. Solcher, solche, solches, such a, also follows the strong declension; but if used with the indefinite article it takes the inflections of the weak declension: solch-em Freunde (strong), to such a friend; but einem solch-en Freunde. Sometimes it is used in the shortened form solch for all three genders, followed by the indefinite article and without inflections: solch ein Mann, such a man; solch einer Frau, of such a woman; solch einem Freunde, to such a friend; solch einen Vater, such a father, etc.

4. In the compounds derjenige, diejenige, dasjenige, and derselbe, dieselbe, dasselbe, der-, die-, das- take the strong, and -jenige, -selbe take the weak inflections.

	Singular	*Plural*
nom.	derjenige, derselbe, etc.	diejenigen, dieselben,
gen.	desjenigen, desselben, etc.	derjenigen, derselben.
dat.	demjenigen, demselben, etc.	denjenigen, denselben.
acc.	denjenigen, denselben, etc.	diejenigen, dieselben.

Both these forms are always followed by the relative pronoun welcher, etc., or der, etc.: Derjenige, welcher (or der) Wind säet, wird Sturm ernten, He who sows wind will reap storm. Derjenige (or der) Mann ist der stärkste, welcher (or der) allein ist, The strongest man is he who is [stands] alone. Es war derselbe Mann, den ich sah, It was the same man whom I saw.

5. The neuters of the demonstrative pronouns are not used with prepositions, but are replaced by compounds of these prepositions with the adverb of place da (dar before vowels): damit, with this (instead of mit dem, diesem, demselben); davon, of this, from this (instead of von dem, etc.); dadurch, through this; daraus, out of

this, etc. These contractions also replace the dative and accusative of dieser and jener, and of the personal pronouns if they refer to inanimate objects. Examples: Hier ist ein Gewehr, spiele nicht damit, Here is a rifle, do not play with it (damit replaces mit ihm, or mit demselben); ich warte darauf (instead of auf es, or auf dasselbe), I am waiting for it; wir sprechen noch darü'ber (instead of über das, über dieses, über es), We shall return to this subject [we will still speak about this].

6. The neuter demonstratives dies (lengthened: dieses) and das are applied, with the auxiliary verb of tense sein, to substantives, without the usual agreement in gender and number. Dies (dieses or das) ist mein Vater, dies meine Mutter, dies mein Kind, und dies sind meine Schwestern und Brüder, This is my father, this my mother, this my child, and these are my sisters and brothers.

XXXVI. Most *strong verbs* with the stem-vowel -e- change it in the imperfect into -a-, and in the past participle into -o- and -e- (which in the latter case means the return to the original stem-vowel). The verbs made prominent in print are conjugated with sein, all others with haben.

Infinitive		Present Tense I., II., III. Singular	Imperfect *Indicative*	Imperfect *Subjunctive*	Imperative	Past Participle
befeh'len	to command	ich befeh'le, befiehlst', befiehlt'	ich befahl'	ich befäh'le *	befiehl	befoh'len
ber'gen	to save, shelter	ich berge, birgst, birgt	ich barg	ich bärge	birg	geborgen
ber'sten	to burst	ich berste, birstest, birst	ich barst	ich bärste *	birst	geborsten
bre'chen	to break	ich breche, brichst, bricht	ich brach	ich bräche	brich	gebrochen
dre'schen	to thrash	ich dresche, drischest, drischt	ich drasch, also drosch	ich dräsche *	drisch	gedroschen
empfeh'len	to recommend	ich empfehle, empfiehlst, empfiehlt	ich empfahl	ich empfähle *	empfiehl	empfohlen
erschre'cken †	to terrify, to be frightened	ich erschrecke, erschrickst, erschrickt	ich erschrak	ich erschräke	erschrick	erschrocken
gel'ten	to tell, to be valid	ich gelte, giltst, gilt	ich galt	ich gälte *	gilt	gegolten
hel'fen	to help	ich helfe, hilfst, hilft	ich half	ich hülfe	hilf	geholfen
nehmen	to take	ich nehme, nimmst, nimmt	ich nahm	ich nähme	nimm	genommen
schelten	to scold	ich schelte, schiltst, schilt	ich schalt	ich schälte *	schilt	gescholten
sprechen	to speak	ich spreche, sprichst, spricht	ich sprach	ich spräche	sprich	gesprochen
ste'chen	to sting	ich steche, stichst, sticht	ich stach	ich stäche	stich	gestochen
stehlen	to steal	ich stehle, stiehlst, stiehlt	ich stahl	ich stähle *	stiehl	gestohlen
sterben	to die	ich sterbe, stirbst, stirbt	ich starb	ich stürbe	stirb	gestorben
treffen	to hit, to meet with	ich treffe, triffst, trifft	ich traf	ich träfe	triff	getroffen
verber'gen	to hide	ich verberge, verbirgst, verbirgt	ich verbarg	ich verbärge	verbirg	verborgen
verder'ben	to spoil	ich verderbe, verdirbst, verdirbt	ich verdarb	ich verdürbe	verdirb	verdorben
werben	to enlist, woo	ich werbe, wirbst, wirbt	ich warb	ich würbe	wirb	geworben
werfen ‡	to throw	ich werfe, wirfst, wirft	ich warf	ich würfe	wirf	geworfen
essen	to eat	ich esse, issest, isst	ich aß	ich äße	iß	gegessen
fressen	to eat (devour)	ich fresse, frissest, frisst	ich fraß	ich fräße	friß	gefressen
geben	to give	ich gebe, gibst, gibt	ich gab	ich gäbe	gib	gegeben
gene'sen	to recover	ich genese, genesest, genest	ich genas	ich genäse	genes(e)	genesen
gesche'hen	to happen, to take place	es geschieht	es geschah	es geschähe	gescheh(e)	geschehen
lesen	to read	ich lese, liesest, liest	ich las	ich läse	lies	gelesen
messen	to measure	ich messe, missest, misst	ich maß	ich mäße	miß	gemessen
sehen	to see	ich sehe, siehst, sieht	ich sah	ich sähe	sieh	gesehen
treten §	to step	ich trete, trittst, tritt	ich trat	ich träte	tritt	getreten
verges'sen	to forget	ich vergesse, vergissest, vergisst	ich vergaß	ich vergäße	vergiß	vergessen
gebären	to bear, to bring forth	ich gebäre, gebierst, gebiert	ich gebar	ich gebäre	gebäre, or gebier	geboren

* Also with ö. † As intransitive (without complement) *strong:* ich erschrak, I was frightened; as transitive (with object) *weak:* ich erschreckte ihn, I frightened him.
‡ To this group belongs also gebären, to bear, which is to be found at the end of the list of this group. § Also with haben in the sense of "to tread on."

EXAMINATION PAPER X.

1. Which substantives are used only in the singular, and which only in the plural?
2. How can a plural be formed of some nouns which in themselves have no plural?
3. To which declension do the demonstrative pronouns dieser and jener belong?
4. In which cases does the declension of the demonstrative pronoun der, die, das differ from that of the definite article?

5. Which declension is taken by the demonstrative pronoun solcher, solche, solches?
6. Which declension is used with the shortened form of the demonstrative pronoun mentioned in 5?
7. In which cases is the use of the alternative genitive of the demonstrative pronoun der, die, das (that) indispensable?
8. Which relative pronouns *must* follow the demonstrative plural genitive derer (of those)?
9. Which declension is followed by each of the two components of the demonstrative pronouns derjenige and derselbe, and by which relative pronouns *must* they be followed?
10. Can the neuters of demonstrative pronouns be used with prepositions?
11. Which compounds replace the neuter of the personal pronoun in connection with a preposition governing the dative or accusative?
12. When is the neuter demonstrative dies exempt from the customary rules of agreement in gender and number?
13. Which are the vowels taken in the imperfect, in the past participle, and in the second person singular imperative, by strong verbs with the stem-vowel -e-?
14. Why is it, in some cases, preferable to use the first conditional instead of the imperfect subjunctive, with verbs whose stem-vowel is -e-?

EXERCISE 1. Change the present tense of the following sentences into the imperfect and into the perfect [see XXXIII.]:

Ich binde einen Kranz; der Vogel singt; das Reh
I bind a wreath; the bird sings; the deer
springt und trinkt; das Werk gelingt; wir trinken
jumps and drinks; the work succeeds; we drink
Wein; das Wasser rinnt ins Thal; er schwimmt
wine; the water flows into the valley; he swims
ausgezeichnet; ich sitze im Garten; das Schiff sinkt;
excellently; I sit in the garden; the ship sinks;
die Glocke klingt laut; der arme Mann bittet um
the bell sounds loudly; the poor man begs for
eine Unterstützung; ich gewinne das Spiel;
assistance (aid); I win the game;
er besitzt ein Haus.
he owns a house.

EXERCISE 2. Insert the missing demonstrative pronouns and other parts of the sentences:

Ein . . . . selten; . . . . ein . . . . ;
Such a friend is rare; such a friend is rare;
. . . . ;
he is the son of this man and of that woman;
wir sprachen mit (3) . . . . Knaben . . . . ;
we spoke to this boy and to those men;
. . . . viel . . . .
she spoke much of her daughter and of her
. . . . ; der Himmel ist
[the daughter's] experiences*; Heaven is
. . . . gnädig, die ihn anrufen; der Jäger
gracious to those who appeal to it; the gamekeeper
marschierte hinter seinem Herrn und trug
marched behind his master and carried
. . . . Gewehr; ich vertraue . . . . . ., welcher
his [the master's] gun; I trust to him, who
mir vertraut; . . . . ? . . . .
trusts me; is this your wife? No, this is my
. . . . . . ; . . . . ;
cousin*; these are her sisters and their husbands*;
sie antwortete, sie würde . . . . Mann heiraten,
she answered she would marry that man
. . . . . . ihr am besten gefiele.
who pleased her best.

EXERCISE 3 (*a*). Rearrange the following sentences by putting the indefinite article *before* the demonstrative pronoun:

Es ist eine Freude, s o l c h e i n e n Sohn zu haben.
It is a joy to have such a son.
Solch' ein Un'glück! Solch' eines Mannes Sohn
Such a misfortune! The son of such a man
sollte von anderer Art sein. Wie konnten
ought to be of different stuff [kind]. How could
Sie solch einer Frau solch eine Unhöflichkeit sagen?
you say so rude a thing to such a woman?
Solch ein Tag ist schrecklich. Solch einem Künstler
Such a day is terrible. To such an artist
muß man solch einen Irrtum verzeihen.
one must forgive such a mistake.
Solch einem Manne, solch einer Frau, solch einem Kinde
Such a man, such a woman, such a child
bin ich noch niemals vorher begegnet.
I have never met before.

(*b*). Rearrange the following sentences by putting the demonstrative pronoun *before* the indefinite article:

Ein solcher Skandal' wegen einer solchen Klei'nigkeit!
Such a scandal on account of such a trifle!
Eines solchen Mannes Pflicht ist Großmut; einem solchen
Such a man's duty is generosity; in face of such
Un'glück gegenü'ber ist der Mensch wehrlos; einen solchen
a misfortune man is helpless; such a
Fall habe ich in einer solchen Familie noch nicht erlebt!
case I have never experienced with such a family!

KEYS TO EXERCISES IN EXAMINATION PAPER IX.
(PAGES 2051-2)

EXERCISE 1. Ich beeile mich; er beeilt sich; du liebst dich; wir retten uns; ich sagte mir; Sie sagten sich; ihr sagtet euch; sie fürchteten sich; ich hatte mir gesagt; wir hatten uns ruinirt; er würde sich getötet haben; sie unterhält sich; wir unterhielten uns; schämen Sie sich! rasiere dich!

EXERCISE 2. Ich habe einundzwanzig Karten; er gab mir zweihunderteinundsechzig Pfund für das Jahr tausend neunhundert und eins; der Lehrer unterrichtet zweiundvierzig Knaben und siebenundfünfzig Mädchen, zusammen neunundneunzig Kinder. Im russisch-japanischen Kriege wurden zweihundertsiebenundvierzigtausend fünfhundert und achtundneunzig Soldaten verwundet — hundertfünfundvierzigtausend vierhundert und siebenunddreißig Russen und hundertzweitausend einhundert und zweiundfünfzig Japaner. Wie viel ist neunzehn und dreizehn? zweiunddreißig; vierzehn und neun? dreiundzwanzig. Einer von euch hat es genommen. Ich glaube es war der eine von den fünf Soldaten; er war der Vater zweier Söhne; er war der Vater von zwei Söhnen.

* The experience, die Erfahrung; the cousin, die Cousine; the husband, der Gatte.

Continued

WILLIAM THE CONQUEROR GRANTING A CHARTER TO THE CITIZENS OF LONDON

From the Painting in the Royal Exchange by SEYMOUR LUCAS, R.A. [See HISTORY]

NOTE BY THE ARTIST. The scene represented is the moment when the Conqueror, attended by his Queen and surrounded by his bishops and nobles, is handing the charter to Godfrey. The architecture is taken from the Chapel of the Pyx at Westminster, which is generally accepted as having been built before the Norman Conquest; the costume is from the Bayeux Tapestry.—SEYMOUR LUCAS

THE FIRST ENGLISH KINGS

Mahomet's Successors. Hengist and Horsa. Alfred and his Reign. Work of St. Dunstan. King Canute. William the Conqueror

Continued from page 2244

By JUSTIN McCARTHY

MAHOMET did not designate his successor to the caliphate or sovereignty which the dying man had created for himself. The title of caliph, which meant lieutenant or vicar of the almighty ruler, came originally from Persia, and was adopted by the Arabians over whom Mahomet came to rule. Mahomet was attended in his latest illness by one of his closest and most powerful friends, Abou-Bekr, whose daughter Ayeshah he had married, and whom he had charged with the duty of pronouncing a farewell message to those around him and to all his subjects. Abou-Bekr was chosen as the successor to Mahomet, and the office of caliph meant the absolute direction of religious, civil, and military affairs. The successor to Abou-Bekr was Omar, and Omar was followed by Othman, and then came Ali, stepson of Mahomet. Ali was said to have been the very first convert made by Mahomet to the Mussulman doctrine, and he was one of the bravest and most devoted followers of the Prophet, whether in peace or in war. His accession to the caliphate gave rise to a religious and political dispute among the Mussulmans, which made its mark upon their history. A large proportion of that party had strongly maintained that Ali himself ought to have been the immediate successor to Mahomet, and during the years which intervened between Mahomet's death and Ali's accession to the caliphate something like a sectarian division sprang up among the Arabian people.

The Arabian Caliphs. After the death of Ali, the caliphate became hereditary, and the Arabs soon began to undertake great expeditions and conquests, with the purpose mainly of compelling the neighbouring nations to accept the doctrines of Mahomet and the Koran. Within a few years Arabian caliphs had made themselves masters of Persia and Egypt, the invasion of Egypt being signalised by a siege of Alexandria which lasted for more than a year. From this time the caliphs became a trouble to all that part of the world within their reach, and in later days they became a trouble even to Europe itself. The Arabian caliphs, indeed, only followed the example which had been set them by the Roman Empire, and the world has seen that civilised and modern States have undertaken the conquest of foreign countries with the avowed object of spreading among them the teachings of true religion. The caliphate dynasties were, in the meanwhile, subject to frequent disturbances, interruptions, and divisions. One sect—that of the Abbassides—set up on its own account, and founded a dynasty of its own. This dynasty claimed to have had its origin from an uncle of Mahomet, and founded a dominion which was described as the Eastern dynasty, and made its capital at Bagdad, a new city built for that purpose on the Tigris. This caliphate gave to the world a succession of famous rulers, most of whom did their best to introduce into the life of the East all the literature, art, and science which had been, and still were, given forth from Greece and Italy.

The Arabian Nights. The most famous of this line of caliphs is Haroun-al-Raschid, or Haroun the Just, whose name has been made known by "The Arabian Nights" to all readers of books, whether adults or children, throughout the world. The adventures which befell Haroun and his favourite Minister Giafar in their nocturnal wanderings through the various quarters of Bagdad have exercised a fascination over most minds at one time or another such as fairyland itself could not surpass. It is to be feared that the impression of Haroun himself which is got from "The Arabian Nights" is scarcely more true to the original than is the picture given of the nocturnal adventures of the caliph and his comrade to the actual conditions of life in Bagdad. Haroun-al-Raschid was, indeed, a great lover and patron of art and letters, and a generous friend to all who deserved distinction in those spheres; he made his Court at Bagdad the centre of all that was brilliant, artistic, and intellectual among his own people or among travellers whose wanderings led them to that part of the world. But it is certain that Haroun the Just does not stand out through the whole of his career as a typical crowned representative of justice. He was luxurious and extravagant in his habits, even for an Oriental sovereign, and indulged in acts of despotic severity not common even among despots. He became possessed by hatred towards the race of the Barmecides, a tribe or race of Persian origin, whom he suspected of designs against himself or his dynasty, and caused the execution of many of the leading Barmecides and their sons. His own grand vizier Giafar, the favourite companion of his life and wanderings, was himself a Barmecide, and in his sudden outburst of fury Haroun ordered the execution not only of Giafar, but of his sons as well.

The Barmecides. The race of the Barmecides has, through the pages of "The Arabian Nights," been enabled to bequeath to English literature a phrase which is in use even at the present time. We still speak of a Barmecide feast when we mean to describe a banquet at which there was little or nothing to eat or drink, and the phrase is taken from the story told by the barber's sixth brother in this immortal story-book.

Haroun-al-Raschid, while marching against a rebellion in one of his provinces, was assailed by a fit of apoplexy, which brought his career to a sudden end. The dynasty of the Barmecides did not maintain its power long after his death, but the Mahommedans continued to be an important factor in the world's history for many succeeding centuries. They made themselves again and again a terror to Europe, and were able to establish settlements for a length of time on European soil.

Influence of Mahommedanism. The Mahommedans, in fact, accomplished the greatest movement of change known to the earth since the Roman Empire ceased to be a ruling power. They obtained, indirectly at least, a very marked influence over the world's literature, as well as over its history, for there was a certain fascination about their life, their manners, their stories, and their poetry, which impelled European writers to make them a constant study and to enrich European romance with ideas, descriptions, and pictures from the storehouse of the Orient. Mahomet the Prophet could never in his wildest imaginings have foreseen the peculiar influence which his people were destined to have on the literature of the world. That influence survives even in the literature of our own days.

The most important work of the Middle Ages consisted in the division of Europe into separate states, representing the several nationalities and characteristics of the European populations. During some centuries this development had been sought after under most difficult conditions, and was interrupted by opposing incidents and forces of various kinds. At one period the classification of the separate nationalities was confused and unsatisfactory. The Franks, and the Gauls, and the Northmen were understood to be made up of the German, the French, the Swedes, Danes and Norwegians. But in process of time it became impossible to consider the Franks as entirely Germanic, or the Gallic nationality as including only the inhabitants of France, or even the inhabitants of that part of Europe which was then regarded as purely Gallic.

The Danes. The Danes were the most venturesome and most powerful of the Northern peoples, and had made their way, by repeated invasion, into countries which they were able to occupy for a time, but which before long compelled them to see that they were looked upon as foreign intruders whose sway could not be endured. In the South of Europe the Spanish races had not yet been clearly marked out into the separate kingdoms which afterwards came to be recognised; and Spain itself had been occupied successively by Carthaginian, Roman, and Moorish invaders. Italy, after the fall of the Roman Empire, had become in great part the centre of Christianity and the home of the Papal power. For a long period one of the world's great struggles was that of Christianity against one or other form of Pagan belief. Rome, representing no longer the Empire of the Cæsars, had come to represent the influence and the power of the Popes and the Popes' claim to occupy the Chair of St. Peter. Russia was regarded as a barbaric region out of touch with the growth of European civilisation.

The Development of States. Gradually, as we have seen, the different nationalities began to shape themselves into separate states. The kingdoms of England and France secured for themselves distinct recognition. The Germanic race, although divided even to our own days under separate governments and systems, had come to be recognised as entirely distinct from the other peoples of Europe. Italy was divided into small states, but was recognised as representing a common nationality. Hungary, after being subjected to the Romans, and afterwards taken possession of by the Goths, was occupied by a Scythian tribe, the Ungrui—from the German version of which name, Ungarn, we get the present name of the country—and by the Magyars, a race of Finnish origin.

It must not be supposed that the principle of nationality was, or ever could be, distinctly preserved in these various settlements. The configuration of the soil, the limits made by Nature as convenient frontier lines, by the sea or by the position of great mountain ranges, or long and broad rivers, had necessarily much to do with the formation of the different states.

The British Islands. We may take the illustration given by the British Islands. These islands would seem clearly marked out by the sea as the natural home of one separate people. But the northern part of the larger island, the Scotland of history, was peopled by a race of men who had not a common origin with the people of England, who spoke for a long time a different language, and had for centuries kings of their own. The other island, Ireland, claimed an origin quite different from that of either Scotland or England, spoke in a tongue almost the same as that of Scotland, and for many centuries was held by England merely as a captive province. Even England herself enclosed people who did not admit a common nationality with that of the English race—the Welsh, who claimed an entirely different descent and spoke a language akin to that of Scotland and of Ireland. The Norsemen, the Danes, Swedes, and Norwegians, while generally regarded by the outer world as representing alike the nationality, the traditions, and the purposes of the people commonly called the Norsemen, never blended, during the course of their history, into one common race and state. The Northmen invaded and made settlements in France, England, and the Netherlands; they invaded Russia, and pressed on to the Polar regions. The Saracens—a name given to the Arab-Berber races of Northern Africa as well as to other Arab races of Asia and of Africa—were famous sea-rovers, who invaded both the western coasts of the Mediterranean. The Hungarians also made a deep mark on the history of the Middle Ages, for they, too, were filled with the spirit of adventure and conquest.

All these various invasions were in time repelled from the foreign countries which they had threatened and endeavoured to occupy, and

Europe began to shape herself into the states which are, for the most part, still existent. The one state which may be regarded as destined to some comprehensive change is that of European Turkey.

Beginnings of the English Race. We may begin the story of the European kingdoms with the history of England. Mr. J. R. Green, in the beginning of his "Short History of the English People," tells us that "for the fatherland of the English race we must look far away from England itself." Then he reminds us that "in the fifth century after the birth of Christ the one country which bore the name of England was what we now call Sleswick, a district in the heart of the peninsula which parts the Baltic from the Northern Seas." The inhabitants of that region were of Teutonic origin. They were known as Saxons by the Romans; and like other nations of that day were much given to the use of ships and to exploring expeditions, with the object of finding out promising and profitable places of settlement. England had been for a long time a province of Rome, and some of her population were already taking to Roman ways and the Roman language; while in other parts of the island the resistance to Roman power was unceasing, and called for successive conquest on the part of Rome. But when the Roman Empire began to fall into decay, and Rome had quite enough to do in the defence of her own Italian regions, there came at once the temptation and the opportunity for the Sleswick races to attempt an expedition with the object of establishing a settlement in the island of Britain. An expedition started in the year 449 A.D., under the leadership of Hengist and Horsa, and landed, as Roman expeditions had done before, on the shores of the Isle of Thanet.

English History Opens. With this landing the history of England begins. The expedition is said to have been invited by Vortigern, one of the many rulers among whom the island of Britain was divided, his object being to obtain the assistance of these renowned adventurers in a struggle against the Picts, the Northern race of the island, with whom war was continually going on. It is believed that Vortigern married Rowena, the daughter of Hengist, in order the better to secure the support of that leader. As we have already seen, the brothers subsequently turned against Vortigern, and made war on him, but were defeated in a battle in which Horsa was killed. Hengist persevered in his adventurous undertaking, and, according to tradition, made himself master of all the Kentish region. He died in Britain many years after. Some considerable time had yet to pass before Britain became united as one kingdom; it had many foreign rulers, and even foreign dynasties.

We need not retrace the history, such as it is, of all these various reigns. Much of the narrative rests on tradition, or on records of very imperfect order. We do not need to make any more than a passing mention of the half-mythical or wholly mythical King Arthur, who is said by some chroniclers to have lived and reigned at an undefined period of the sixth century. King Arthur and his Knights of the Round Table make their appearance again and again in legends or in pretended chronicles of England, Scotland, Wales, and even of France; and if we were to attach any real importance to these chronicles and legends we should have to assume that King Arthur appeared again and again in life during far divided periods of the world's history, even as one of the divinities of the Greek or Roman mythology might be supposed to do. One success may be ascribed to him whether he be mythological or no—he has created a remarkable figure in the literature of poetry and prose.

Alfred. There are, however, some distinguished names to be recorded during this long period—some English rulers who made an enduring mark, not only on the history of England, but on the history of the world.

Alfred the Great, as he was justly called, won for himself what promises to be an undying celebrity. He was King of the West Saxons; was born in Berkshire, in 849, and was taken to Rome to pass there some of his early years. He was the youngest of five sons born to his father, King Ethelwolf; but in 871, at the age of twenty-two, he succeeded to the throne on the death of his brother Ethelred. At that time the Danish occupation of England was growing more and more widespread, and, indeed, the greater part of England north of the Thames was under Danish rule. Alfred, before his accession, had served in a battle against the Danes, and the victory of Ashdown was won chiefly by his courage and military genius.

After Alfred's accession there were nine battles between the Danes and West Saxons, and some years later Guthrum, who ruled over the Danes of East Anglia, made a sudden invasion of Wessex, at first with complete success. Alfred's military resources were for the time exhausted, and he had to abandon resistance and find a temporary place of refuge for himself and the remainder of his forces in the marshy regions of Somersetshire. Here, raising a fort at Athelney, he maintained himself and his followers. It is certain that during that period he spent his time chiefly in making preparations for another attempt against the Danes. In the same year, 878, not long after his retreat, he suddenly came forth at the head of an army and inflicted a complete defeat on the Danes. The Danish sovereign, Guthrum, had to accept terms of peace, one of these being to receive baptism as a Christian; he had also to acknowledge the supremacy of Alfred in all the regions south of the Thames and in the greater part of Mercia.

Alfred as "Over-ruler." The Danes still retained their hold of East Anglia, but Alfred regarded them as merely foreign invaders, and continued his preparations for their complete expulsion. He sent out a fleet against them in 884, and two years later occupied London and fortified it. In 893 Northumbria

accepted him as its sovereign, and he finally became the acknowledged "over-ruler" of Britain.

Alfred had, however, from time to time, more trouble with the Danes on account of his anxiety to relieve the country as far as possible from their disturbing presence. Despite his many wars, he had long intervals of peace, which he employed to the noblest account.

Administration of Alfred. Though he had come to be recognised as the ruler of all Britain, this position was not that of a sovereign as reigning over one undivided State. There still remained during Alfred's time several minor kingdoms with their hereditary kings; but Alfred was recognised as holding a position higher than all these, and representing the whole people of Britain. Throughout his long and methodical labour for the improvement of the realm he had as closely in his mind the interests of one part of the country as of another. He busied himself with works of improvement, which extended their influence from the southern shores to the extreme north of England. He took measures for the defence of his country along its coast, and for the bettering of the system of legislation which he found existing in the realm. His exertions mitigated the savagery of some of the penal laws which still prevailed, and he did his best to construct a codified and equalised system of legislation for the whole country. He had no dreams of foreign conquest: his ambition lay nearer home.

While organising these reforms, Alfred devoted himself to his daily tasks with an application which would have done credit to the most hard-working member of a business firm. While engaged in the establishing of schools throughout the country, he actually superintended the educational work of a school he had founded for the sons of the nobility around his Court. With all his practical work, he was an intense lover of music, and by his influence and example did much to promote the spread of a cultured taste for music among all who looked up to him as a spreader of light. He was a scholar and a literary man as well as a maker of laws; he translated the celebrated book of Boethius, the Roman author, on "Philosophy's Consolation," histories written by the Venerable Bede and by Orosius, and other great foreign books. No man ever devoted himself more thoroughly and more unceasingly to the promotion of education, morals, prosperity and happiness among his fellow men than Alfred did throughout the whole of his reign.

The Alfred of Story-books. There are numbers of legends retained in literature concerning Alfred and his days. One of the most familiar of these is the famous story of Alfred's entering a peasant's cottage, not being recognised by the wife of the house-owner, and offering to assist her in the baking of her cakes. Alfred cheerfully consented to do the work, and the woman left him in order to attend to some of her outdoor duties. In her absence the King, becoming absorbed in thoughts concerning the welfare of his realm, forgot all about his appointed task, and allowed the cakes to burn. The good woman returned to find her cakes spoilt, and the young man who had undertaken to look after them not paying the slightest attention to them. She relieved her feelings by violently scolding her unrecognised sovereign, who listened with bland good humour and without a word of remonstrance. The legend is even still a subject of allusions in English writings. It is in all probability a myth, but a myth which effectively illustrates the manner in which Alfred was regarded by his own people. No such story would ever have been told of a monarch who was not recognised as conspicuous for his sweetness of temper and keen appreciation of humour.

Alfred died on the 27th of October 901, at the age of 52.

Then came the reigns of successive rulers, one of whom was regarded as supreme over all the rest, according to the precedent which had been set up in the days of Alfred. The Danes continued their invasions and settlements, and the whole story of those years is but a repetition of the efforts to obtain England for the secure ownership of the English. There were struggles, too, with the Welsh, for some of the English kings endeavoured to invade Wales, and Wales in return sometimes invaded England.

St. Dunstan. One of the most important and picturesque figures of those times was that of Dunstan, the famous ecclesiastic known to the world as St. Dunstan, Archbishop of Canterbury. He was the son of a West Saxon nobleman, was born in 924 A.D., and was educated at Glastonbury Abbey, where he took the monastic vows, and for a time lived the monastic life. He was, however, by nature designed for the work of education and of reform, not merely in ecclesiastical but also in political affairs. On the accession of Athelstan's brother Edmund, he went to Court, and after a period of disfavour was appointed Abbot of Glastonbury in 945. Then he began with effect his great work as an educational reformer, and was at the same time the close adviser of King Edmund. Dunstan had among many artistic qualities a passionate love of music, and in his wanderings through the country he carried his harp in his hand, and struck its chords to delightful music, after the fashion of the harpers renowned in early song and story. He did not obtain the support of Edwy, the successor of Edmund, and there was a strong feeling against him amongst some of the courtiers whose advice was powerful with the new King. Dunstan left the country and took refuge in Flanders, but was afterwards recalled to England; during the reign of Edgar he was created Bishop of London.

After Edgar became supreme King of Britain, he appointed Dunstan Archbishop of Canterbury. Dunstan took part with the Archbishop of York in the Coronation of King Edgar on Whit Sunday 973, a ceremonial intended to demonstrate that the whole kingdom of Britain was thenceforward to be recognised as one realm. The great object of Dunstan's statesmanship was to establish and maintain a national

policy while establishing also the principles of equality, fairness, and justice in the civil code of the realm. Even the Danes in England he would not regard as enemies, but endeavoured to make them good citizens of the country by allowing them to retain their own nationality and customs.

Britain as One Realm. For sixteen years Dunstan ruled under King Edgar not only the ecclesiastical but also the civil affairs of the State. During all this time there was peace in England, whose condition seemed to be in every way improving. On the death of Edgar, in 975, Dunstan gave his support to Edward, elder son of the late King, and performed the coronation ceremony at Winchester. In 978 Edward was murdered at a feast by a robber whom he had banished from his realm; and it was mainly owing to Dunstan's firmness and energy that the succeeding prince, thus called so suddenly to the throne, was able to maintain the order of the realm without interruption. During Dunstan's administration continuous efforts were made to abolish the system of slavery which had prevailed up to that time in almost every country, and his efforts were so far successful that they impressed the intelligent public with a sense of the horror attaching to the system. From that time forth there was a continuation of the policy, which may be said to have had its first political impulse from Dunstan, which attempted not merely the abolition of slavery horrors but the creation of a public opinion which should lead to its entire abolition.

Canute. Dunstan died at Canterbury in the year 988, and his death seemed to have given a new opportunity for that spirit of disunion and disorder which he had so long been able to repress. The several kingdoms reasserted their independence, and in each of them lawlessness began to prevail. The West Saxons rose in one region, the Danes occupied another. The latter captured Canterbury, and there Ælfheah, the Archbishop, was murdered.

For a time England seemed to be given up to strife between the North and South for supremacy, with frequent interruption of invasions by the Danes and the efforts towards their expulsion. Edmond Ironsides, one of the English overruling sovereigns, struggled for a while, and with some apparent success, against the conquering Danes, under the leadership of Canute; but he was overthrown in a decisive battle, and his death shortly afterwards left Canute master of the field. Canute was not a foreigner in anything like the same sense as the Norman rulers who governed England in later days. The language of his forefathers differed far less from that of the earlier English stock than did the language commonly spoken in many of the districts which had lately set up as separate states in England.

Canute was one of those men who only show their true nature when they become exalted to a position which enables them to follow the dictates of that nature without compromise and without consideration for opposing influences, whether of race or of tradition. He had sanctioned, ordered, and even committed many acts of capricious cruelty before he became recognised as the highest ruler in Britain; but on his arriving at that supreme eminence he became at once the genuine Canute. He had a great intellect, a keen power of observation, and a sincere desire to make his people happy and himself beloved by them. He devoted himself to a policy of humanity and justice, an effort to introduce the principle of civil equality into the government of the island, to maintain peace within his own dominions, and to enable every one of his subjects to enjoy in security the results of his own industry, skill, and good behaviour. Canute had in him much of the artist as well as of the statesman, and composed poems which are still recorded in the history of literature. His great aim was to carry out in the rule of England the principles of Dunstan; and he did all that he could by precept and example to uphold the belief that communities must be governed by religion and its teachings in the first instance, and by systems of civil law consistent with such doctrines. He had a great scheme, which he regarded as patriotic and practicable, but which proved in the end a fatal obstacle to the complete realisation of his best ambition.

Canute's Dream of Federation. He desired to unite some of the Northern Powers of Europe, such as Denmark and Norway, into a complete confederation with Britain, under his own rule, and to govern these countries by equal and enlightened laws. This project did not at the time seem so chimerical as it might have done some ages later. There was then no English people as we now understand the words. A great part of the island had been occupied and settled by peoples and rulers of different races, and Canute regarded the northern men as having the best and nearest claim to relationship with the England of the past. The project was, however, beyond his power of accomplishment; and if Canute could not have carried it to success, we may feel sure that no other man in his place could have done more than he.

England was beginning to concentrate herself within her own sea-washed shores, and to endeavour to found a distinct nationality there. Some of Canute's domestic measures, such as the forest laws, which he introduced with the object of reclaiming vast tracts of land that had been allowed to run to waste or had become the home of wild animals, were regarded with disfavour by many of his subjects, who did not approve of any disturbance offered to the old and traditional ways of the country. His reign was, on the whole, one of peace and general content, and forms a most important landmark in the history of England. He died on the 12th of November, 1035, and was laid to rest at Winchester.

Character of Canute. Many instances are recorded of Canute's nobility of character, his generosity, and his appreciation of the duties which belong to a throne. One of the most famous stories tells of the stroke of practical humour with which he turned to ridicule the grotesque flattery of some of his courtiers who thought to please him by

declaring that he was privileged to execute omnipotent rule over all the conditions of life within his realm. While sitting on the seashore as the tide was coming in the King offered to test his power over the elements by commanding the waves to recede or stand still. The waves, however, held on their way, and the monarch and his too flattering courtiers had to take flight to escape being swallowed up by the sea.

A Period of Unrest. After the death of Canute came an interval of renewed wars and troubles, and a succession of Danish and Saxon kings whose reigns did little for the progress of England's civilisation. Canute's dreams of a great and abiding union between England and the northern countries came to nothing. The Danish kings who succeeded Canute were for the most part barbaric tyrants; and the fact that Canute had been able to establish for so many years a rule of peace, order and justice, made the inhabitants of Britain more impatient of the wanton misdeeds committed by those who came after him. The rule of the Danish sovereigns soon came to an end. A remarkable figure among these later kings was that of Godwine, Earl of the West Saxons. Mr. Green tells us that "Godwine is memorable in our history as the first English statesman who was neither king nor priest." He was a man of humble birth, and, according to some authorities, the son of a peasant, but he succeeded at an early age in making himself remarkable by his practical ability and versatility. He thus became useful to Canute's brother-in-law, and his success carried him so far that he became Earl of Wessex. He has an especial interest because of the important position he took in bringing about the change in English feeling which led to the extinction of Danish rule in Britain and the establishment of the line of Norman sovereigns after Edward the Confessor. Godwine had done his best after the death of Canute to maintain the policy of the late Sovereign, and to prevent the breaking up of the Danish rule; but the acts of Canute's Danish successors made it clear that this policy had no hope of success. Godwine died in 1052. His daughter was married to Edward the Confessor, the last of the old line of Anglo-Saxon kings. The history of Edward's reign illustrates the continuance of the struggles between the several factions and influences which were groping about for some policy destined to secure a continued nationality and system of government for Britain.

William, the Man of Destiny. The man was coming to the front whom destiny would seem to have created for the purpose of giving to Britain a line of continuous sovereignty with which no minor or local rulers were to interfere. He was born in Normandy and will ever be known as William the Conqueror. He was the illegitimate son of Robert, Duke of Normandy, and his mother is said to have been the daughter of a poor tanner whom the Duke of Normandy had seen washing linen in a stream near his palace, and with whom he fell in love. William was protected and brought up by his father, and when the father died, leaving no legitimate heir, the influential nobles of the Court accepted him as successor to the dukedom. The dukedom was then a dominion, resembling in its nature some of the minor sovereignties of Britain, and the young duke had much trouble to contend with. Some of the nobles of the duchy rose in rebellion against him, and King Henry of France had to come to his help with a strong force to enable him to crush the rebels on the battlefield. William visited England in 1057, in order that he might spend some time with his cousin, Edward the Confessor; and during their intercourse he was encouraged by Edward to think of obtaining the succession to the English throne.

Qualities of William. William impressed all around him with the sense of a commanding individuality. He seemed to concentrate into a single form that era of warlike enterprise, of invasion and of conquest, which was drawing to a close in the greater part of Europe, and that era of recognised laws and separate nationalities which was just beginning to dawn upon the world. William had the characteristics of the daring soldier, the military adventurer, even of the freebooter and the pirate, but he had also those of the statesman, the legislator, and the founder of dynasties. His face and figure commanded attention. He had the height and form of a giant, a stern although handsome face, and enormous strength, with an equal skill in every form of physical exercise. During all his early struggles in Normandy he displayed not only a courage which never could be shaken, but a temperament which seemed to become more composed and calculating as the dangers in his way increased. He had many of the faults common to his times. He was cruel to his enemies, unsparing in his revenge, and often ordered the infliction of tortures the mere description of which would shake the nerves of a modern reader. But as to his undaunted courage and his military capacity there could be no question. It is said that Julius Cæsar could always distinguish, even at the height of some hotly-contested battle, what it was possible for him to accomplish and what would be impossible. William seems to have had much of the same quality.

The Battle of Hastings. On the death of Edward the Confessor, in 1066, Harold, the second son of Earl Godwine, claimed the throne, was elected king as Harold II., and crowned in Westminster Abbey. But William of Normandy had by this time resolved to assert his own claims, and was all the more resolved to do so because he believed Harold had at one time urged him to seek the succession. England was invaded by Hardrada, King of Norway, but Harold inflicted a complete defeat on the Norwegian invaders in a battle at which Hardrada was killed. William, however, had yet to come. He landed in England four days after. On October 14th, he defeated Harold in the famous battle at Senlac, a few miles from

Hastings. The battle went on from early morning until late evening. William of Normandy was completely victorious, and Harold was killed. William then became King of England, and his position was recognised by the Pope. He had still to put down many uprisings against his rule, and for some years a great part of the country was devastated by war; but in 1070 the conquest was complete. In 1087 William was engaged in a war with Philip I. of France, and during the course of the war he had Mantes, a small French town, burned. While he was riding through the burning town to see that his commands were carried out, his horse stumbled, and he was flung to the ground, receiving injuries from which he died at Rouen, on the 9th September, 1087. Thus perished by a commonplace, or even an inglorious, accident, one of the greatest soldiers and commanders of early history.

The Beginning of Feudalism. The reign of William imposed upon England a feudal constitution. The old national assembly of the realm was converted into a council of the sovereign's tenants-in-chief, all title to land being derived from the King's grant. Domesday Book, or Doomesday Book, was one of the products of King William's reign; it was, at least, begun under his authority, and was intended as a register to determine the right to the tenure of estates, to ascertain the quantity of every landowner's due to the State, and the amount of military assistance which each landlord was bound to render to his sovereign in case of need. The book is still preserved in the Public Record Office, and consists of two volumes, one large and one small. The survey which it proposed to make was enlarged at later periods, and the taxes were levied according to its system down to the reign of King Henry VIII., when a new survey was taken and many alterations in taxation were made.

William may be said to have introduced into England the feudal system which had been practised from earlier times in Germany and France, and must have been in operation in one form or another during the earlier formation of most states. According to the principle established by William, the kingdom was divided into Baronies, which were given by the sovereign on the express condition that each holder should supply the king with men and money for warlike enterprise. William became entangled in many troubles with the Barons, because, although they cordially approved of that part of the system which made the vassals who held land under them bound to pay for their land in personal military service as well as in money, they did not approve of the development which William was giving to it. The purpose of the sovereign was to convert the whole State system into feudalism, with the King as supreme head, and the nobles as his vassals, just as the lower orders of the landowners were to be the vassals of the nobles. The result was that William was met with serious resistance here and there by the Barons, and at one period there seemed to be a national crisis at hand. The King's strong will and great intellectual resources made him triumphant, however, and he became the supreme power in the State. He exercised control even over the Church, and decreed that no excommunication could be issued without licence from the sovereign, nor could any synod legislate without his assent.

The Jews in England. One important effect of William's reign and its policy was the settlement in England of a vast number of Jewish traders, whom he encouraged and enabled by his protection to find homes in England. The Jew was then, as Mr. Green puts it, "the only capitalist in Europe," and the spending of his money gave an impulse to the manufactures and the industry of his new home. The money of the Jews helped the King frequently in his struggles against his rebellious Barons. The Jews were not treated as citizens nor as having any of the civil rights, such as these were, which belonged to the Christians; but they were allowed to conduct their business in Britain, and the Christians had no hesitation in getting all the benefit they could from their money. The story of the treatment of the Jews in England is not one which can be read all through with much satisfaction by English students, but William, who first encouraged their settlement in England, dealt much more fairly with them than did many of his successors. William the Conqueror was, indeed, a man in advance of his age. He was, according to his lights, a reformer as well as a great soldier, and most of his errors and wrongdoing belonged to his period rather than to himself. His reign opened a new era in the history of England.

Continued

Group 1 AGRICULTURE 17 FARMING continued from page 2240	# SHEEP AND PIGS Short-woolled, Long-woolled, and Hill Country Breeds. Management and Breeding. Shearing. Breeds of Pigs. Building of Sties. Feeding

By Professor JAMES LONG

SHEEP

Great Britain is extremely rich in its breeds of sheep, which are usually classified as Short-wools and Long-wools; the latter, however, may consistently be divided, the mountain breeds being separately distinguished. British sheep are chiefly produced for the butcher, but some of our important breeds not only grow abundant, but fine and valuable wool, and although the market price of this commodity is now low, breeders continue to take pains in the selection of their stock with the object of maintaining the quality of the fleece as well as the form of the animal and the quality and the quantity of its meat. There has long been a tendency to produce mutton of excessive fatness, and this is largely owing to public competitions, but since the introduction of the carcase competition at the London Smithfield Show, and the revelations which have accompanied it, great pains have been taken by the judges to discount excessive fatness and to encourage breeders to produce mutton more suitable to the requirements of the market by the increase of the lean meat on the best parts of the carcase and the reduction of the amount of fat. From year to year have we noticed in examining this splendid display that many of the animals which were awarded prizes when alive were so imperfect in the carcase that the thickness of the fat over the loin reached as much as two inches.

A THREE-SHEAR TUP

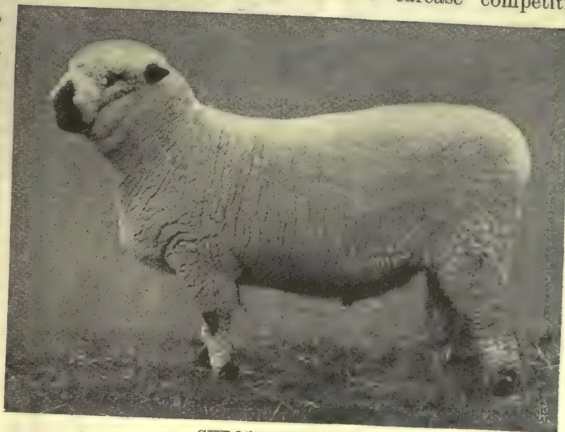
Adaptation of Breed to Environment. The importance of breed in the maintenance and prosperity of a flock can scarcely be overestimated. Some varieties are suitable, like the Southdown, to the chalk hills of Sussex or Hampshire; others to the lowlands of the Midland and other counties; others, again, to the mountains of the North; or, like the Romney Marsh breed, to low-lying, wet land, which encourages foot-rot and other diseases in those classes of sheep which, owing to heredity and constitution, are unsuited to soils of this class. Our principal varieties are remarkable for their massive form or their symmetry; but we must not be entirely guided by what we see at livestock exhibitions, for the perfection of form which so many animals present is often owing to the skill of the shepherd in his manipulation of the wool with the shears. Depth, width, and the finer lines of form are constantly imparted by this somewhat improper and mistaken practice. Nor can we acquit some exhibitors of going still further, for where colour is a point with the judges, portions of white wool are constantly removed from among the black on the face or forehead—as we have personally witnessed—with no other object than that of gaining a prize. Many varieties of sheep, too, are coloured with ochre of different tints, so that the visitor to a show may fail to recognise in some exhibits the name of a breed which has thus been disfigured.

The Names at Various Ages. Sheep, according to their sex and age, are known by different names in different localities. Thus, the male lamb is first known as a ram or tup-lamb; subsequently as a yearling or shearling ram, or tup, after his first fleece has been removed. After a second shearing, he becomes a two-shear ram, or tup. A male sheep, too, which has been castrated, is known as a wether lamb, a wether hogg, a tegg, or a hogget, until his first shearing. After the clipping of the first fleece the male sheep is known as a wether or shearling wether; while after the second clip he is described as a two-shear wether. Two-shear wethers are, however, seldom, if ever, exhibited at our fat-stock shows, the tendency being to feed for the butcher before the second shearing season; and for this reason, except for the necessary ultimate feeding of tups and ewes for consumption, almost all British mutton is now young and tender. The female lamb is known as a ewe-lamb; next as a ewe, or hogget, or ewe-hogget, and after a first clipping as a theave, or gimmer, or shearling ewe. In some districts, however, the young ewe is described as a "tuttuth," or a two-tooth; after the appearance of the second pair of permanent incisors, she is known as a four-toothed, subsequently as a six-toothed, and lastly, when

the eight incisors have all appeared, as a full-mouthed ewe. When these teeth commence to fall, the ewe is known as a broken-mouthed ewe, and her value for breeding stock or mutton has diminished. Indeed, the money value of a sheep declines, except in particular instances, when she has grown six permanent incisors.

SHORT-WOOLLED SHEEP

The Southdown. Not only is the Southdown, with which his Majesty the King has been so successful, the most perfect in quality, form, and character, of any of our native breeds, but it is the one variety which has been employed with marked success in the creation of several other short-woolled breeds. It is a small sheep, compact, small-headed, and short-legged, and covered with fine, close wool. It is rather dark faced, produces the finest of meat, and is employed for crossing purposes with the greatest success. Its home is the Sussex Downs, but it is bred by a large number of flockmasters, professional and amateur alike, on dry lowlands, for it is not suitable to land of a wet character.



SHROPSHIRE RAM

The Shropshire. Somewhat similar in type and form to the Southdown, but slightly larger, the Shropshire owes much of its existence to the Royal breed. It possesses a dark face, ears, and legs, the face being remarkably woolled; it produces splendid meat, and is now used very largely in crossing for the improvement of inferior breeds or mixed flocks. No variety is, perhaps, so largely exhibited, and none have been so quickly perfected. It is adapted to almost any climate, inasmuch as it is hardy and prolific, and is approached in character, form, or quality by very few of our native breeds.

The Oxford. Sometimes known as the *Oxford Down*, this is a massive, short-woolled sheep, larger and coarser than the Shropshire, with dark-brown face and legs, excellent form, and a thick, useful fleece. It produces fine early lambs, and is largely bred in parts of the Midlands and South-West of England. It owes its character to the blood of the Cotswold, the Hampshire, and the Southdown.

The Hampshire Down. Bearing some resemblance to the Oxford, the Hampshire Down is also a large, somewhat coarse and massive sheep, with very dark face and legs, and is chiefly bred in Hampshire and Wiltshire, although, like the Oxford, it is a favourite with many outside flockmasters. It produces a big early lamb, which quickly runs into money, makes a most excellent cross, and owes much of its quality and the splendid flavour of its meat to the Southdown.

The Suffolk. A newly-improved breed which also owes something to the Southdown, the Suffolk has been brought rapidly to the front by a few skilled breeders, who maintain the somewhat dense blackness of its face, ears, and legs. No sheep has shown better quality in the carcase competitions; owing to the comparative largeness of the quantity of lean it produces and the smallness of fat on the best parts of the carcase it is invaluable. It resembles the Oxford and the Hampshire in size, and is covered with fine, close wool. The Suffolk is a hardy and prolific variety.

The Dorset Horn. The most remarkable of all English breeds for its early prolificacy and its Christmas lamb is the Dorset Horn [page 257]. Indeed, we may say more—it is associated with the production of two crops of lambs in the same year, although there are doubts as to the wisdom of the practice of breeding so rapidly. It is a sheep of average size, for it takes a medium position between the heavier long-wools, such as the Lincoln and the Leicester, and the mountain breeds of the North and West. Its fleece is close, and of medium length, the head carrying a forelock. Although the Dorset is chiefly bred in Dorset and Somerset, it is fancied by many flockmasters in other parts of England.

The Ryeland. A white-faced breed of long standing, resembling the Dorset in size, the Ryeland produces good meat, but shorter wool, of fine quality. It is not largely bred, and is, indeed, little known out of Herefordshire and neighbourhood, its place being more or less taken by the Shropshire, which produces a better cross. Like the Dorset, it is adorned with a forelock.

LONG-WOOLLED SHEEP

Lincolns. The Lincoln [page 257] is the largest and heaviest sheep grown in these islands, probably in the world. Although with us it is chiefly confined to Lincolnshire, numbers are exported for the improvement of foreign and Colonial flocks, the breed being hardy, the feet sound, the fleece very heavy—reaching up to 15 lb.—and the wool of high quality. The joints, however, are large, the sheep being easily fattened. A ram of this breed has reached 1,000 guineas under the hammer, so much is it valued for export. The Lincoln owes much to

the blood of the Leicester, which is an older variety, both face and feet being white.

The Leicester. The old-established breed, the Leicester [page 258], which is the foundation

DEVON LONG-WOOL RAM

of many British varieties, was produced by the famous Robert Bakewell, at a time when British sheep, like British cattle, were in the making. Though slightly smaller than the Lincoln, it is a large sheep, with white feet and legs, covered with wool of good quality, and producing meat which is neither so close nor so fat as that of some other breeds, although it is easily fattened. The Leicester is much used for crossing purposes, and may be regarded as the progenitor of the Border Leicester and the Wensleydale, which are, practically speaking, collateral branches of Bakewell's handiwork. The Leicester, which is known as the Dishley in France, is largely kept in the Midlands, either pure or in flocks of the Leicester type, and right up to the Scottish Border.

The Border Leicester. This variety, much admired, bred, and exhibited by Mr. Arthur Balfour, is a handsome, hardy sheep, with open, curly wool, and most prolific as a breeder. It stands rather high on its legs, but is smart in appearance, and carries a sharply-cut typical head. It is bred largely in the Border counties, and is in great demand for crossing purposes in Scotland.

Cotswolds. The most striking and handsome of all British varieties is, perhaps, the Cotswold. These sheep are chiefly bred on the Cotswold Hills, are very large in size, covered with a brilliant white curly fleece, and have white faces and legs. The joints reach almost as heavy a weight as those of the Lincoln, but they are somewhat coarse and fat, the carcases reaching great size. The Cotswold makes an excellent cross.

Kent, or Romney Marsh. The Kent, or Romney Marsh breed is a big, massive animal, with white legs and face, a black nose, and plenty of wool of most excellent quality. It is especially hardy and suitable for those districts where foot-rot is most easily acquired, for it maintains its feet in sound condition with but little attention. It is largely kept on the marshes of Kent, and owes a great deal to the Leicester blood which runs in its veins.

The Devon Long-wool. Chiefly bred in Devon, West Somerset, and Cornwall, like so many other local breeds the Devon Long-wool has been immensely improved by crossing with the Leicester. It has a white face and legs, an attractive forelock, fine wool, and a weighty carcase, although the meat is rather coarse. There is a local variety known as the South Devon, the legs and faces of which are dark, but the fleece is handsome, and the wool silky in texture.

Wensleydale. This variety, which is in large part a descendant of the Leicester, to which it owes so much of its character, both direct and through the Teeswater branch, is kept in the famous Yorkshire dale after which it is named. It is dark-faced, with a forelock, and carries a fine, curly fleece. The blue skin is a characteristic of the breed, and enables the amateur to select it with unusual ease. The Wensleydale is extremely handsome, well built, and produces good meat.

Roscommon. This is practically the only pure breed of sheep peculiar to Ireland. It is large, covered with a heavy fleece of fine, silky wool, and is a producer of most excellent meat. It is handsomely formed, although in this respect it falls short of the best English varieties, to which in many cases it is first cousin, owing to the blood which has been imparted to it by the famous Leicester.

HILL COUNTRY BREEDS

The Black Faced. This is a characteristic and most picturesque Highland sheep, hardy, with black or mottled face and legs, and curly or spiral horns. The carcase is small, and the wool very long, open, coarse, and shaggy. The Black Faced is often brought into England for feeding into mutton, but is a persistent wanderer, breaking through hedges with ease, and hence it is unsuitable for small farms. It is believed to be a pure race, but crosses well, and makes excellent mutton, although the joints are small.

The Lonk. This variety closely resembles the Black Faced in appearance, especially in

WENSLEYDALE RAM

face, horn, and the length and character of its wool, but it is larger in size, and chiefly bred in the hills of East Lancashire and West Yorkshire. It is extremely handsome.

The Cheviot. This is a medium-sized sheep, with white face and legs, and a very characteristic Roman-shaped nose. The fleece is of medium length, and the wool close, but the carcase is not sufficiently square and compact. It is chiefly bred in the Lowlands of the North.

The Limestone Variety. The Limestone is a white-faced, horned, fine-woolled sheep, somewhat over medium size, very hardy, and is kept in the district of the North-West of England.

The Herdwick. A breed of somewhat uncertain lineage, found in the hill countries of Cumberland and Westmorland, the Herdwick carries a white fleece, the wool being coarse, somewhat hairy, and sometimes spotted. There may or may not be horns.

The Welsh. This is a small variety, producing very finely-flavoured mutton. The joints are quite small and much esteemed. The face is white, and the wool fine and soft. Occasionally Welsh sheep are horned.

The Exmoor and Dartmoor. Bred in the Devonshire hills, the Exmoor is a horned, white-faced sheep, quite hardy, and carrying a short, close, soft-woolled fleece. Although it is not well-formed—wanting in squareness—it crosses well, and produces excellent mutton. The Dartmoor breed [page 258], which is quite distinct, is larger than the Exmoor, also quite hardy, with white face and legs, and long, soft wool. The carcase is of medium size, and the meat of high quality; the breed stands much exposure.

The Clun, or Radnor Forest. This is a local variety of sheep, found in Shropshire and adjacent Welsh districts. It is descended from an ancient breed with a tanned face, of which it still shows something in the tinge of the mottled face of to-day. It has been improved by crossing with the Shropshire. The wool is rather coarse, but the mutton is of excellent quality.

MANAGEMENT OF SHEEP

Rearing and Feeding. In the British Islands sheep are chiefly bred for mutton, and as the public taste is decidedly in favour of lean meat, the flockmaster should take special pains in the selection of his breeding stock and in the arrangement of his rations. The sheep usually exhibited at our "fat-stock" shows are excessively fat, from two to three inches being frequently found upon the back and loin, while the oyster part, or lean of the mutton chop, is relatively small. The loin indeed should be much leaner, and the remark applies to every joint of the carcase. The waste on the saddle, neck, and leg is frequently so considerable in ordinary butcher's meat that the cost of the edible portion is quite doubled. Although wool takes a second place, the skilful breeder, in selecting his breeding flock, will take care to reject ewes with coarse, hairy, or wiry wool, and to retain those which carry the heaviest fleece of wool of fine quality.

Selecting Breeding Rams. In the selection of the breeding rams, it is important to secure constitution, vigour, form, well-shaped legs, broad and deep loins, width behind the shoulders, neat heads, and heavy, but fine fleeces. In practice, the type or breed of sheep selected is that best suited to the district. This especially applies to low-lying, or damp soils, and high-lying, or uplands. From year to year fresh pedigreed rams and ram lambs should be selected, two to every hundred ewes. By adopting this practice, and by systematically rejecting inferior or weakly ewes, a flock may be gradually built up, as well in character as in quality, size, and constitution. It is important that the ewe should have a large, perfect udder, or she may not be able to rear her lambs, especially when she bears twins. The ewe should be young, possessing not more than four permanent incisor teeth; indeed, in a breeding flock, it is wise to sell the ewes before or by the time sixth teeth have appeared. They should never be kept, special circumstances excepted, until they have become broken-mouthed.

SHEARLING BLACK FACE *Reid*

Care of the Breeding Flock. The breeding flock should always be kept in good, but not fat condition. Early maturity is the order of the day; and that lambs may grow well and be ready for an early market, the ewe should be kept in such a condition that she will supply abundant milk to provide for their sustenance and rapid growth. In the South of England rams are mated with the ewes about the first of September, while the further we go North, the later the date selected. At this time the ewes may receive a liberal ration, say, three-quarters of a pound of decorticated cotton-cake, or a mixture of this cake with bran or oats. The practice not only assists in improving the general condition, but is almost universally believed to influence the number of twins, which is a great point. In Dorset, as with many breeders of the Dorset horned sheep, it is customary to produce lambs for Christmas; while in the adjoining

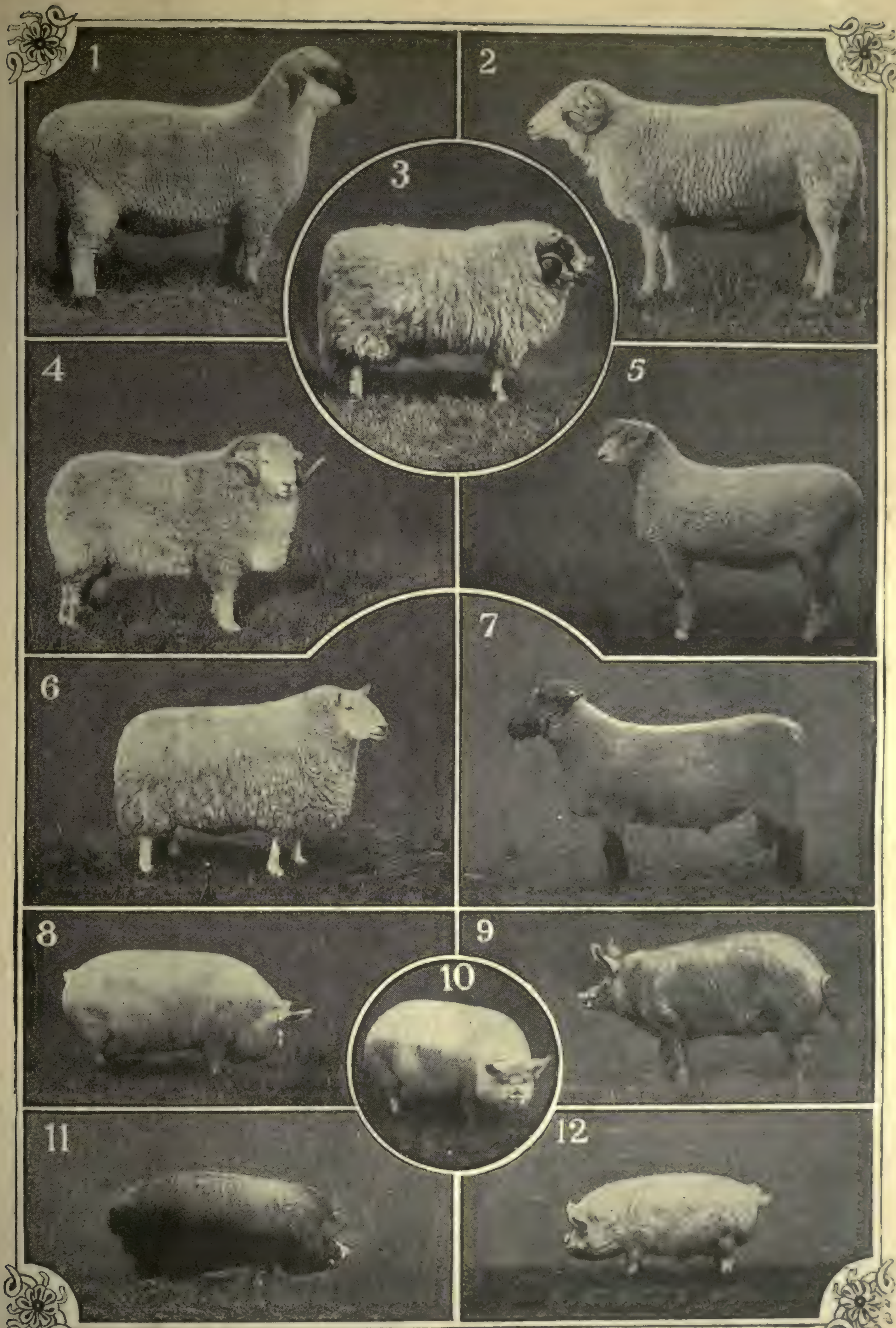
county of Hampshire, lambs of the Hampshire Down flock come next into the market.

Management of a Flock. A great deal of forethought is needed in the management of a breeding flock. It is imperative, for example, to arrange earlier in the year where sheepfolds for use in the lambing season should be built, and consequently where hay and straw stacks should be erected, for the one should be contiguous to the other. The stacks may be arranged two or three together, to form shelters, the folds being constructed close to them, and on the warmer side. In this way straw for covering the pens, for providing shelter around the hurdles, and for littering the inside of the fold is easily obtainable. Sheep at all times require some form of protection, but never so much as during the lambing season. The ewes lamb with ease, but where difficulties arise, and the shepherd's help becomes necessary, he should be required to anoint his hands—and this is really imperative—with carbolised oil, to prevent the conveyance of infectious germs, and the possible death of the ewe. After lambing, the ewe and her single, twins, or triplets, should be placed in one of the small lambing - pens erected with hurdles under cover, and within the fold. The form of the sheep-hurdle differs in accordance with the district and the material grown for its manufacture. In many cases, wattle hurdles, made of hazel, are constructed on the farm. In others, open gate-hurdles are made of split ash ; in others, hurdles of similar form, with pointed feet, and made of sawn common deal, are purchased from a manufacturer. The average hurdle is fixed to a pair of pointed stakes driven into the ground with a beetle, the two being linked together with an oval iron ring. For protection in severe weather a fold may be enclosed by two sets of hurdles or wattles, placed close together, with straw between.

ROSCOMMON RAM

Weaning Lambs. Lambs are usually dropped at the end of five months, or from 140 to 150 days, but the actual period of gestation varies from 140 to 151 days. Professor Henry's observations of the flock of 500 ewes on the Wisconsin Experiment Farm point to 146 to 149 days on which the largest number and the strongest lambs were dropped. The actual range was from 145 to 149 days, although in odd cases the extremes of 140 and 151 days were reached. The sex of the lambs appeared to make no difference, but it is believed that early maturity has reduced the period of pregnancy. The majority should be twins, but many singles appear, and sometimes triplets. Twin lambs weigh nearly or quite as much as singles, from 8 lb. to 18 lb. at birth, in accordance with the breed and the condition in which the ewe has been maintained. The males weigh slightly more than the females. The lambs are weaned at from 12 to 24 weeks old, having been well fed from birth, both through the ewe and from the trough, after trough-feeding has commenced. On arable sheep-farms the breeding flock is placed upon turnips or swedes, the latter being still on the ground. On the forward side of the fold, lamb creeps, or gates, through which the lambs can pass but not the ewes, are fixed between the hurdles, and thus the lambs are able to go forward and nibble the younger portion of the tops of the roots, and to feed from troughs provided with special rations of linseed cake, crushed oats and bran, or some similarly useful food. On the following day the fold is moved forward, the ewes consuming what the lambs have left, while the lambs again go forward among the fresh roots. At the same time the ewes are provided with food, three-quarters to one pound a day, composed of cake, crushed oats or bran, crushed maize, malt coombs, a few crushed beans, and hay chaff, with long hay placed in specially made racks. Similar arrangements may be made on grass land, if necessary ; but usually the flock, ewes and lambs alike, are at liberty, and changed from field to field as the herbage becomes scarce and the ground soiled. The ram lambs are castrated at from 10 to 14 days old. Where the removal of the tail is customary, it is cut a little earlier, so that the two operations are not carried out at the same time. In either case it is well to avoid severe frosty weather.

Avoidance of Wet Land. As forage crops come in—vetches, rape, sainfoin, clover, and cabbage—the flock is folded upon them, as in the case of the turnip and the swede, but no sudden change should be made from one food to another, the introduction to the new food being gradual. It is important to remember that wet land is bad for both ewes and lambs, introducing both foot-rot and fluke, a disease of the liver. Ailing ewes or lambs should be examined immediately their condition is in the least abnormal. Foot-rot is contagious, and affected sheep should be at once removed, and the feet pared and dressed with a lotion or ointment obtainable of any druggist. A well-managed flock in which foot-rot ever exists should be occasionally driven through a trough slightly filled with a solution intended to maintain the feet free from any taint of the disease. Wet grassland should be avoided at any cost, sheep frequently consuming organisms which cause scour, sickness, and death. Nor should any sheep be introduced which has been in contact with sheep suffering



TYPICAL SHEEP AND PIGS

1. Hampshire Down Ram Lamb 2. Welsh Mountain Two-shear Ram 3. Lonk Ram 4. Herdwick Ram 5. Cotswold Ram 6. Cheviot Ram 7. Suffolk Ram 8 and 10. Middle White Sows 9. Tamworth Boar 11. Berkshire Boar 12. Small White Boar

from scab, the most foul and destructive of the complaints of the flock.

Food for the Flock. Arrangements for the production of food for the flock should be made long before it is required. The area sown for its consumption will depend upon the number of animals retained and the number of lambs expected. On the arable farm these crops will be grown upon land which is fairly dry in a wet season—*i.e.*, through which the rain easily passes. A good shepherd will, in making this arrangement, be a great help to his employer. He is usually a lover of his flock, and will think of points which may escape his master. The shepherd is always anxious for the sheep to thrive, hence he is almost certain to provide for the best, and to supply his charges with all the hay and grain he can obtain in reason. While the ewes are with the lambs, as already observed, they may obtain from ¾ lb. to 1 lb. of cake and grain daily, both being crushed, the finer portion of the cake going to the lambs together with 1 lb. of hay, part of which will be cut into chaff. As green foods come in the hay will be reduced, and when the ewes are receiving vetches, clover, or sainfoin, or, indeed, any leguminous foods, the cakes and beans supplied in the troughs may be reduced also, and the carbonaceous foods, such as crushed maize or barley, slightly increased. At the same time the ewes may receive slightly less corn and cake, and the lambs more. The wether lambs should be better fed than the ewe-lambs, and pushed on for market, the latter being kept for stock, with the exception of those which are rejected, which should be fed for the butcher with the wethers. Through the summer ewes and lambs may be kept on dry pastures, except when forage crops are provided, but always fed for the maintenance of good condition. As the harvest fields are cleared, they will be taken on to the stubbles, which they will clear of weeds and stray ears of corn. The growth of successive green crops, roots and cabbage, is all-important on the arable sheep-farm. For the older ewes, and especially those which are broken-mouthed, swedes, when supplied, may be sliced daily. Salt should always be provided, and where there are no ponds, water fetched and kept handy in troughs.

Dipping. Sheep are dipped for the purpose of destroying parasites, some of which are dangerous to health and life, while others prevent thriftiness. Dip mixtures may be made on the farm or purchased of manufacturers. The latter plan is strongly recommended as the simplest, safest, and best. Information as to the most successful preparation is easily obtainable from experienced flockmasters. Home-made dips are prepared by the admixture of arsenic, carbolic acid, soda, and soft-soap, but owing to the dangerous character of the two poisons, we strongly suggest that they should be left alone. The dip being mixed with water in accordance with the instructions of the maker, and placed in a tub of sufficient size, the sheep may be lifted in one by one, the whole body, the head excepted, being kept under at least a minute, and this should be timed by the farmer, watch in hand. Mechanical dipping-vessels are made which simplify and reduce the labour of handling, which is considerable, but there is no surer and safer plan than that of hand dipping as suggested. The beginner will do well to witness both methods, and choose for himself. Dipping is seldom practised more than once a year, but it should be performed twice to keep the flock perfectly safe. Efforts are being made to pass a law rendering sheep-dipping compulsory, in consequence of the many dangerous and costly outbreaks of sheepscab.

Clipping. Before the annual sheep-shearing, the whole flock should be well washed, a fine sunny day being selected a week to a fortnight before the removal of the fleeces. The process removes the "suint"—a material excreted from the skin which forms from one-sixth to more than one-third of the weight of the wool—and much of the fatty matter of the wool, which also adds largely to its weight, with the result that washed fleece weighs less than the unwashed fleece, the former realising a higher price per lb. Owing, however, to the trouble involved, many flockmasters have abandoned washing, regarding the increased weight of the wool "in the grease," as it is termed, as an equivalent to the loss of price per lb. Clipping is annually performed by hand, although mechanical clipping-machines are employed by many large flockmasters. On large sheep-farms the shepherd and his assistant, sometimes with help, carry out the work, but generally small gangs of men travel a district and shear the flocks for their owners at so much per score. The wool is usually sold to a dealer on the basis of market price. Sometimes, however, large farmers make a practice of buying the clippings of small flockmasters, and consigning them with their own to the great buyers of the North. The value of the wool not only depends upon its condition—whether washed or unwashed—but upon the breed and the smallness of the fibre, which varies very much in diameter. The best wool grows upon the back and neck, the inferior upon the belly. The clippings of the short-woolled breeds contain the most fatty matter. [See TEXTILES, page 1120.]

In judging sheep, form, size, and quality of wool are chiefly taken into consideration. Where the colour of the face and legs forms a point, this also is considered. It is, however, a common practice amongst shepherds to clip sheep before exhibition in order to give them compactness, massiveness, and symmetry. The time has arrived, however, when important prizes should be withheld from exhibits so manipulated, and it will be well when committees of great exhibitions provide for the removal of the fleece of the competitors for breed cups and champion prizes. This plan has been adopted in France with great advantage.

Age. Sheep have 32 teeth, eight being incisors, none of which are in the upper jaw. The temporary incisors are well up at the end of four weeks, and the permanent incisors at the end of three years. The first permanent incisors

to appear are the centrals, at the end of a year; the second pair at a year and a half, right and left of the first pair; and the third pair at two and a quarter years. According to the Smithfield regulations, where the central permanent incisors are cut, the animals are considered as exceeding 10 months, and where they are fully up, as exceeding 12 months old. When the third pair of permanent incisors are cut, the sheep are regarded as exceeding 19 months, and when fully up as exceeding 24 months, if the temporary molars have been shed. Where the fourth, or corner, pair of permanent incisors are well up and show marks of wear, sheep are regarded as exceeding three years old.

Weights of Sheep. On the basis of the weights of sheep exhibited annually at Smithfield Show, lambs gain from 8 oz. to $11\frac{1}{2}$ oz. per day from birth, and wethers under two years from $3\frac{3}{4}$ to 8 oz., in each case depending upon the breed and the system of feeding adopted. Show sheep thus gain unusual weights. The heaviest sheep are the Lincolns, Cotswolds, Leicesters, Kents, Suffolks, Hampshires, and Oxfords, and these, as a rule, make the heaviest daily gains in weight. The butcher's carcase of a sheep weighs from 50 to 60 per cent. of the weight of the live animal, depending on its condition, whether lean, half-fat, or fat, and whether the fleece has been removed or not.

AVERAGE WEIGHTS AND DAILY GAINS OF FAT SHEEP AT SMITHFIELD

Class.	Average Weight of Class in 1905.	Daily Gain from Birth. Average of 1903-4-5.
	lb.	oz.
Lincoln lambs	216	11·67
,, wethers	334	8·36
Cotswold lambs	192	10·59
,, wethers	307	7·46
Leicester lambs	153	10·53
,, wethers	272	7·36
Suffolk lambs	184	11·27
,, wethers	290	7·25
Hampshire Down lambs	188	9·92
,, ,, wethers.. ..	284	6·59
Oxford Down lambs	191	10·46
,, ,, wethers	293	6·84
Kentish, or Romney Marsh lambs	158	9·87
,, ,, ,, wethers	267	6·87
Devon Long-woolled lambs ..	183	10·75
South Devon lambs..	228	8·75
Dorset, or any other pure Short-woolled breed lambs	195	9·01
Ryeland wethers	208	5·22
Shropshire lambs	157	9·19
Cheviot lambs	141	9·37
Southdown lambs	146	8·30
,, wethers	194	4·94
Mountain Breed lambs	127	8·76
,, ,, wethers	195	4·91

PIGS

The entire male pig is known as a boar, a brawn, or a hog. When cut, or castrated, he is described as a hog, a shott, or a store. The young female is known—and the term varies with the district—as a gilt, yelt, or elt. After having produced young, she becomes a sow, and if cut for the removal of the ovary, which enables her to feed for weight more rapidly, she is a spayed sow. The young family of a sow is known as a "litter," or "farrow," while parturition, or giving birth to her young, is recognised as farrowing, or littering.

The Large White Breed. This variety, which is the finest in existence, and one which has been largely exported for the improvement of swine in all parts of the world, is the result of skill and selection at the hands of English breeders. Although a white pig, it is occasionally found with black spots or patches. The head, although long, is really of medium length considering the size of the animal, the snout being slightly inclined upwards. There is great width between the eyes, the ears are large, carried forward, and slightly drooping. The neck is comparatively fine, and the collar, the meat of which is inferior, medium. The shoulders are strong and broad, the back straight, and of great length; the ribs are rather flat, and there is plenty of width of loin and thickness behind the shoulder, giving the heart plenty of room. The tail is set high, and is fine and curly. The hams are large, and the legs of medium length. In many animals the hair is very fine and scanty, but it should be fairly abundant, silky, and strong. The Large Whites reach great weights and enormous size. The young pigs are large at birth, and grow rapidly, but they do not fatten so easily as the Middle Whites or Berkshires at this stage. The meat is of first rate quality, and carries a larger proportion of lean to fat than the Middle or Small Whites. Good strains have fine constitutions and produce large litters. Many white pigs are described as of the large breed without any claim to this designation, although they are sometimes quite pure. Breeders and feeders too frequently sell animals for breeding stock which are mere mongrels, or which are the wasters or culls selected from their litters. The home of the Large White pig is Yorkshire and Lancashire, but it is now bred in all parts of the country.

The Middle Whites. This breed is the produce of a cross between the Large and the Small White, all three breeds having formerly been known as Yorkshires. Its size is about midway between the Small and the Large, and its purity is often determined by the form of its head, which is below medium in length, with a short turned-up snout, a broad face, ears of medium length carried slightly forward, a heavy, fatty collar, and a body which is deep, thick, and compact. The back is straight and broad, there is plenty of depth through the heart, a wide loin and heavy hams, placed on rather short, straight legs. The Middle White fattens rapidly, but it produces meat which carries too much fat in proportion to its lean. It is, however, excellent for crossing, especially if a well-bred boar is used on large, lengthy, lean sows which are not well bred. The hair is plentiful, strong, and silky, and the tail curly and carried rather high. The Middle White

pig is bred in all parts of the country, but cannot be recommended with such confidence as the Large White.

The Small White. This variety, which has long been established, is, practically speaking, a fancy pig, more suitable for the amusement of the amateur than for utilitarian purposes. It is too small either for the production of profitable porkers or useful sides of bacon. Its growth is slow, although it puts on fat with rapidity, while its meat contains far too much fat in proportion to lean. The body is chubby and carried on short legs. The face is small, the snout short and turned-up—a great point in the breed as an exhibition animal—the ears are small and almost erect, the collar heavy, the tail set on high, and the hair abundant, strong, and usually wavy or even curly. The breed cannot be recommended for profitable purposes whether in its pure form or as a cross.

The Large Black. This breed is promoted by the Large Black Pig Society, which was established in 1898, and which has adopted a shield as a trade mark. The variety, which is largely bred in Devon and Cornwall, Essex and Suffolk, as well as in many other parts of England, is of gentle disposition, a good pasturer, a good feeder, and of undisputed merit as a utilitarian animal. The following description of the points of the breed are taken from the "Book of the Pig."*

"Head, medium length, and wide between the ears; ears, long, thin, and inclined well over the face; jowl, medium size; neck, fairly long and muscular; chest, wide and deep; shoulders, oblique, with narrow plate; back, long and level (rising a little to centre of back not objected to); sides, very deep; ribs, well-sprung; loin, broad; quarters, long, wide, and not drooping; hams, large and well-filled to hocks; tail, set high and not coarse; legs, short and straight; belly and flank, thick and well-filled; skin, fine and soft; coat, moderate quantity of straight, silky hair. Objections: head, narrow forehead or 'dished nose'; ears, thick, coarse, or pricked; coat, coarse or curly, bristly mane. Disqualification: any other colour than black."

Not only are great weights reached by the Large Black, but as the table which appears in this lesson will show, the variety puts on great weight per day during its earlier years. The proportion of lean to fat is large, possibly as large as in any other variety of pig, while the inferior parts of the carcase are relatively light.

The Small Black. The Small Black pig is now little bred, while it has been entirely removed from the list of exhibition pigs. It was formerly known as the Black Essex, Suffolk, and Dorset. Although once larger than the Small White, it is almost identical with it in form, character, and quality; the face, however, was never so short nor so characteristic as that of the Small White breed. In other respects, to describe the one is to describe the other. It is not a farmer's pig. The hair is abundant and strong, although silky. The meat is too fat, the growth slow, and the variety, although gradually dying out as a pure breed, has been to some extent employed in building up the Large Black, which is so much superior for economical purposes that the small variety is not again likely to take a prominent place.

The Berkshires. This is still the chief of the Black breeds, although the pure Berkshire pig has white points,—*i.e.*, there is a white blaze on the face, white feet, and a white tip to the tail. The variety is hardy, prolific, a producer of first-class meat, which is sufficiently lean for the public taste and very popular in all parts of the country. At the exhibitions the Berkshire classes are more extensively filled than those of any other variety. The head is of medium length, the face slightly dished, the neck of medium size, the back straight, the shoulders well developed, the loin broad, the body deep, providing good sides or flitches of bacon, the hams well developed, and the legs of medium length. The skin is less of a dead black than that of the other Black breeds, many strains presenting a plum-coloured tinge. The hair is medium in quantity, but occasionally too coarse. No variety of pig is more symmetrical, especially when fattened for the great winter exhibitions.

The Tamworth. This is one of the oldest breeds of British pig, and it has been much less crossed for improvement by Neapolitan and other imported swine, which were used in the manufacture of the Whites and Small Blacks. The Tamworth, which is chiefly kept in the counties of Stafford and Warwick, is of a bright sandy colour, although usually described as red. The brilliancy of the tint changes with age, and becomes rusty or sandy grey, the skin being sometimes patched or spotted. The Tamworth is hardy, of great length, and provided with excellent sides. The head is long and the face comparatively narrow; the ears are large, the neck fine, the back straight, the body deep, the shoulders and loins well developed, and the meat well furnished with lean. The poorest parts of the carcase, as the collar, are not so fully developed as in the breeds already named. Although the Tamworth is one of the very best varieties for economical purposes, it is much less generally kept, and yet it is a prolific, vigorous, and highly valuable pig. In form, it is not equal to the Whites or the Berkshire pigs, but it grows to large size, is easily fed for the butcher, and carries little waste.

Breeding. In the breeding of swine, it is essential to provide for size, rapid growth, without excess of fat, and good constitution. It is also important in the selection of parent stock to ensure stamina in the progeny and large, healthy litters. The sow should be of known healthy, fast-growing, and fast-feeding stock. She should be large, for upon her the size of the young depend in greater measure than on the sire. She should be provided with 12 teats, and produce plenty of milk for the nourishment of her little family. It is important that she should be gentle in disposition. After farrowing, ill-tempered or badly

* "Book of the Pig," by James Long. (Upcott Gill.)

bred sows frequently resent the intrusion of the stockman, and are occasionally apt to wilfully destroy their young. Other sows become careless and indifferent to their litters, and frequently lie upon and crush them, for which reason it is important that in a littering sty a rail should be erected some eight or nine inches from the wall on either side. The selected sire should possess fine points rather than great size, for his influence in imparting quality, colour, symmetry, and type of head, is much greater than that of the dam. He should, moreover, by his possession of super-excellent qualifications on those points in which the female is deficient be expected to counteract the dam's deficiency. A heavy boar is undesirable, but while he should be of full quality, there should be no excessive aptitude to fatten rapidly.

Purchasing Stock. In the purchase of young stock for breeding purposes, there is no better plan than that of making a selection at one of the large exhibitions, where the best pigs are shown, and thus ensuring not only purity, but quality and size, where size is needed. It may be necessary to pay a high price, but this is as nothing compared with the losses which may follow the purchase of badly bred or inferior animals. This method is one of the few which really ensures the acquisition of reliable breeding stock. The sow, if born early in the year—as she should be—should be served in order to obtain her first litter of the year at an early date, and thus to ensure two litters annually. She is pregnant four months, or about 120 days at the outside, while she comes into season every three weeks. Thus, if she remains with her litter for eight weeks, slightly more or less, a period of a week only can intervene between weaning and the commencement of breeding for the second litter of the year if service has not obtained while she is with her young. It is important that the second litter should be born in such time that the young may be weaned and hardened off, as it were, before the arrival of Christmas or severe weather. Thus, if the first litter of the year arrives in the middle of March, and the sow is mated with the boar again about the middle of May, the second litter should be ready for weaning by the middle of November. Pigs born in the spring and weaned as suggested, have the advantage of the summer for exercise and grazing in case they are intended for stock or to run on as stores, both being of great advantage for invigorating the constitution and maintaining a healthy form of growth. On the other hand, pigs entirely restricted to the sty from birth onwards, are quite unfitted for stock purposes; in these days of rapid fattening and maturing, they are better adapted for conversion into meat.

LARGE BLACK SOW

The castration of the young boars may follow soon after weaning, care being taken that they are strong and healthy. Once this operation is witnessed, care and pluck will enable any capable man to do it himself. If allowed to reach a more mature age before the pig's castration is performed, it becomes less simple and more severe, the hot iron being necessary, which is not the case when they are quite young. The gilts are sometimes spayed—*i.e.*, their ovaries are removed with the object of expediting the fattening process. This operation, which is severe, needs greater expertness, but in skilful hands few are lost. We do not, however, advise spaying, nor believe it to be necessary, the advantage not being equivalent to the risk involved.

Feeding and Rearing. The object in feeding the pig is the production of meat with sufficient lean to suit the demands of the trade with as much rapidity and on as small a quantity of food as possible. Hence the importance of selecting appropriate stock for the reproduction of young animals which will mature early, and which will not put on an undue proportion of fat; and next the necessity for exercising due care in the arrangement of the rations. Young pigs, while with their dams, should learn to feed upon the middlings which she receives, but before weaning they should be occasionally supplied—if possible, in an adjoining compartment into which they can pass without the sow—with an occasional handful of wheat or barley. While suckling her young, the best food for the sow is middlings, sometimes termed "shorts," "dan," or "randan." This may be supplemented with a few brewers' grains, some roots, and skimmed milk, all assisting in the production of milk for her young. After weaning, the young pigs may still be supplied with the middlings and milk. Good barley meal with the former should be gradually introduced, until barley meal and milk are supplied alone. The best and most economical ration for rapid fattening is barley meal, skimmed milk, and a few boiled potatoes, but it is most important that the meal should be of high quality. Far too often the meal consists of ground imported barley containing too large a proportion of husk and too small a proportion of flour. To this is sometimes added the grindings of the refuse or cleanings of other grains, which are removed in the mill. Many feeders, especially Americans, prefer maize meal to barley meal. Equally good weights are secured by the employment of maize, skimmed milk, and potatoes, but maize affects the quality of the fat, which becomes yellowish and less firm. Where young pigs are intended for rapid fattening for the market, whether as porkers or baconers, they should be supplied with such food as they

will consume and clean up; but where they are intended for stock or store purposes—*i.e.*, fattening at a later period—the food supplied may be less in quantity, and consist of a mixture of middlings and barley meal, with just a few roots in winter, and with clover, lucerne, or vetches in summer, or, if they are turned out for exercise—as is advisable in breeding stock—grass, to which they can help themselves in the fields. As pigs are wide foragers and venture far from home, especially in the acorn season, they are liable to commit damage both on the property of their owners and that of his neighbours, hence the importance of fencing small paddocks adjoining the sty occupied by pigs kept for breeding or later feeding. Both breeding and store pigs may receive a few handfuls of beans, peas, wheat, or oats, daily.

Bacon-curing. In Ireland the bacon cured in the large factories of Limerick, Waterford, and elsewhere is chiefly the production of pigs fed upon potatoes and milk, oftentimes with but little grain; while in Denmark—the greatest bacon-curing country in the world for its size—pigs are largely produced by the aid of skimmed milk from the numerous butter factories, which are in the hands of the farmers. Thus butter and bacon production in these two countries go hand in hand. Maize, when supplied, may be given cooked in the form of meal, but it is questionable whether the cost of cooking is covered by the decreased cost of feeding. Where young pigs, after weaning, are fed with great care and economy, they frequently put on 1 lb. of live weight for every 4 lb. of maize or barley meal consumed. As they grow older week by week, the weight of grain required to produce a pound of live weight is increased, but in feeding porkers and young baconers the quantity of grain consumed should not exceed 5 lb., or thereabouts, per 1 lb. of live weight increase.

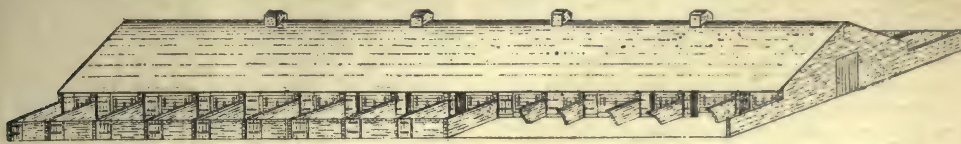
The selection of food, like the selection of breeding stock, is of great importance. Pig feeders, who supply important bacon-curing firms, are sometimes paid on the basis of the depth or thickness of the fat upon the back. Where the fat is excessive, the feeder receives a lower price than where it is moderate in quantity; yet, knowing this fact, feeders send pigs to Smithfield and other shows with over 3 in.—sometimes approximating to 4 in.—of fat, a depth which we have actually measured, on their back. Curers, like retailers of fresh pork, prefer what are termed sizeable pigs. Porkers, for example, should not exceed from 100 to 120 lb. in their carcase. Feeding must therefore be arranged on the basis of the buyers' demands, or prices will suffer.

Care of Pigs. Pigs require warm sties in cold weather, otherwise their increase in weight is less rapid. Their sties should, if possible, face the south, the floors may be made either of sparred wood, the interstices just sufficiently wide for the manure and liquid to pass beneath, or they may be of glazed, non-porous brick laid in cement, or of asphalt or concrete. Each floor, where solid, should be made so that the liquid is carried into an outside drain, and the remark equally applies to the floors of the outside court leading to the sty. The feeding trough, occasionally built in the wall of the outside court, is better fixed into the partition on the inside of the sty, where a passage leads through the building. It may be of iron, with partitions where several pigs are fed together, or of fireclay. A gate should hang above it so that the attendant by bolting the gate back inside of the trough may supply the food without interruption by the pigs, and then, after having done this, he may swing it towards the passage and bolt it on that side of the trough. In every case it is well to provide a wooden bench in one corner of the sty upon which the pigs may lie perfectly dry and warm, straw being supplied in winter, or whenever necessary, wheat straw being the best, while barley straw should be rigidly excluded. For warmth in winter, straw, loose or in bundles, may be packed over the inside of the sty upon poles laid under the roof. If this is not sufficient, a sliding door may be fitted next to the court to keep out the cold air.

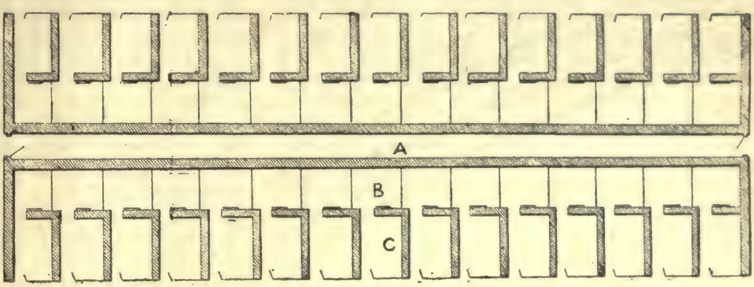
Food for Store Pigs. Pigsties should be solidly built, together with the walls, gates, and partitions, the roof being tiles for warmth in preference to slate or thatch. Pigs should always be supplied with a few coals or cinders, which they consume, and which assists digestion. Sucking pigs are usually sold under three weeks old. After weaning, the sow may still be fed upon middlings, a smaller quantity being given, supplemented by roots, cabbage, small unsalable potatoes, garden refuse, house waste, a few handfuls of grain or beans, some brewers' grains, or if she can be set at liberty, she may be allowed to graze, failing which, in spring and summer, green food may be supplied in the form of clover, vetches, lucerne, or sainfoin. In all cases sows and store pigs may receive in addition to the above foods buttermilk or whey, but meat should never be supplied, although it is a common practice to feed it with liberality in the form of slaughterhouse offal. It is, too, a common practice to turn the pigs of the farm on to the stubbles after harvesting, but its wisdom is questionable. What is saved in food is frequently lost in weight, for by excessive foraging and undue exercise pigs fail to increase in weight. The plan may be adopted in the case of store pigs or breeding sows if no danger of damage to neighbours' property is to be apprehended. Pigs are inveterate rooters, tearing up pastures and meadows unless they are rung, a practice which, unnecessary in the sty-kept pig, is imperative where animals are turned loose. The simplest rings are circular, split, and pointed at one end. They are fixed to the snout by the aid of pliers made for the purpose. Although the pig is reputed to be a dirty animal, cleanliness is most essential in the sty, the court, the trough, and the food.

Points and Judging. The chief points of the pig are size, form and quality. Following these are the colour, and in the Berkshire, the marking of the head, ears, feet and tail, and the form of the face and snout. In judging pigs,

form should be allied to size, which taken alone is not altogether an economical feature. Form assumes a minimum quantity of meat on the worst parts of the carcase and abundance on the best parts, such as the hams, sides, and loins. Form also embraces sufficient width of body where the heart and lungs are situated, for their development and play. In judging black pigs it is important to notice whether they have been artificially blacked to cover white spots or weakness in the depth of the colour of the skin.



LORD MORETON'S PIGGERY AT TORTWORTH COURT
Height from floor to ridge, 14 ft. 6 in. Width (interior), 27 ft.; including yards, 49 ft. 10 in.



GROUND PLAN
A. Central passage, 149½ ft. long by 5 ft. wide. B. Sties. C. Outer yards

It is also essential to determine, in judging young pigs, whether their age is correctly described, or whether they are represented as younger than they really are. British pigs practically suit all climates—except in the case of the Tamworth, which are almost restricted to one part of England—and are found everywhere. This is, in a measure, owing to the fact that pigs are almost essentially sty-fed stock largely depending upon purchased food, and, therefore, but little influenced by soil, rainfall, or temperature. The choice of variety chiefly depends upon the breeder's individual preference and the custom of the district in which he lives, this custom being governed in its turn by the preferences of the butcher and the dealer.

Weights. Young pigs may gain as much as 2 lb. in a day, but as age increases, during the fattening period the increase diminishes. The weight gained, too, depends largely upon the breed or cross-breed. Thus, the cross-bred pigs under nine months old which showed the highest gain at Smithfield in 1905 had made a gain of 1 lb. 10·8 oz., while the greatest gain made by a pair of pigs between nine and twelve months old was 1 lb. 5¼ oz. Compared with these figures the gains made by the Small Whites shown at the same time were very small, 13·1 oz. for the younger and 12¼ oz. for the older pigs. At the same exhibition the highest gain made by a single pure-bred pig was 1 lb. 10½ oz., for a Large White just under twelve months, while the highest gain for a pair of pure-bred pigs was 1 lb. 9¼ oz., made by Large Blacks under nine months old. The following table, however, supplies details of the weights gained by pairs and single pigs of the leading breeds and cross-breeds respectively at the Smithfield exhibitions of the past three years.

AVERAGE WEIGHTS AND DAILY GAINS OF FAT PIGS AT SMITHFIELD

BREED AND AGE	Average Weight of Class in 1905.	Daily Gain from Birth. Average of 1903-4-5.	
	lb.	lb.	oz.
Small White—Two pigs under 9 months	206	0	12·83
,, Two pigs over 9 and under 12 months	243	0	12·18
Middle White—Two pigs under 9 months	287	1	2·68
,, Two pigs over 9 and under 12 months	372	1	1·96
Large White—Two pigs under 9 months	369	1	5·70
,, Two pigs over 9 and under 12 months	428	1	4·64
Large Black—Two pigs under 9 months	334	1	5·30
,, Two pigs over 9 and under 12 months	467	1	5·11
Berkshire—Two pigs under 9 months	313	1	3·66
,, Two pigs over 9 and under 12 months ..	413	1	2·85
Tamworth—Two pigs under 9 months	290	1	2·21
,, Two pigs over 9 and under 12 months ..	413	1	2·58
Any distinct or cross-bred—			
Two pigs under 9 months	379	1	5·30
Two pigs over 9 and under 12 months ..	426	1	4·90
Single Pig—White breed not above 12 months ..	439	1	4·29
,, Black ,, ,, ,, ...	447	1	4·49
,, Berkshire ,, ,, ,, ...	393	1	2·11
,, Tamworth ,, ,, ,, ...	423	1	2·74
,, Any distinct or cross-bred not above 12 months	397	1	3·24

Continued

Group 3
PSYCHOLOGY
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OUR KNOWLEDGE OF OURSELVES

Assimilation of Knowledge. The Folly of "Cramming." True Education. Awakening of Self-consciousness. Optimism and Pessimism

By Dr. C. W. SALEEBY

The Stupidity of "Cramming." The thoughtful reader will immediately understand why it is that cramming is such a useless method of study. The whole essence of cramming is to spend one's time, not in associating the items of one's knowledge, but in making them as numerous as possible per unit of time. The consequence is that the knowledge so obtained is retained only in proportion to the native retentiveness of the memory, which, in any case, is incapable of improvement, even by assiduous cramming for years. This cannot be too strongly insisted on—that though facts unquestionably come to be remembered by sheer repetition, there is no improvement of the memory in consequence; so far as the discipline and development of the memory are concerned, no mechanical methods are of any value. This, of course, is not the same thing as saying that they are of no value in so far as they help us to retain the subject to which they are applied; but it remains true that the only means of disciplining, developing, and strengthening the memory is to be found in association.

If this be true—and it is true—we are immediately supplied with a most important touchstone of educational systems. For instance, in learning how to conjugate a Greek verb, and, indeed, in all the learning of languages, which is arbitrary, the facts having no reasons that are given to the student, and there, therefore, being no associations formed—the mental discipline is nil.

Cramming is bad Discipline. Now, to be quite candid, it does not matter a straw what is said by the survivals from the old notions of education. They may assert until they are exhausted that their methods alone develop the mind, despite the unfortunate argument against them which their own minds display. In so far as this controversy is concerned, the psychology of memory is definite, precise, and demonstrative. The issue must not be confused. Those who recommend an imperfect knowledge of the apparently arbitrary grammar of the classics are entitled to say, if they please, that their practice involves a fine moral discipline; that it is a good thing to the boy who wants to be at the practice nets or on the ice to have to sit down and memorise the pluperfect of a Greek verb—a tense, by the way, which is never, or hardly ever, used by Greek authors. As to the moral discipline we are not here concerned. It is not our business to appraise the value of the moral discipline which consists in making a person do what he dislikes to do, on the simple ground that he does dislike to do it.

But in this course we are entitled to consider the alleged mental discipline of the so-called classical system—which was not practised and would have been execrated as idiotic in classical times. The psychology of memory teaches us, first of all, that there is no mental discipline whatever in cramming, and anyone will recognise at a glance that learning a declension is cramming. Furthermore, the old methods of learning by rote — that is to say, learning without reason, or without the association of ideas—inflict a positive injury, besides failing to accomplish that development of the mental powers which—and not the accumulation of undigested knowledge—is the end of education. The power of associating becomes atrophied by disuse, and the student comes more and more to rely either upon vain repetitions or upon the artificial devices which are usually known as mnemonics. These have an unquestionable practical value, comparable to that of large pockets in one's coat; but they have no more value in enabling one to use one's mental possessions well than a large pocket has in enabling one to use one's material possessions. To possess a very large number of items of information by such means is not to have a good memory in any sensible sense of the word.

The Best Memory. To have a good memory, in the proper sense of the word, is to have a good mind, to have a capable and vigorous thinking apparatus. It follows unquestionably that, in choosing subjects for the earlier scholastic education—the so-called primary and secondary education—it is necessary either to choose those which have utility in themselves, or those a knowledge of which depends upon, and in its turn tends to produce—accurate, ready, complicated, and yet controlled associations of ideas. The difference, in a word, is the difference between learning the first proposition of Euclid so that you are completely nonplussed when the letters are changed, or learning it so that you do not care what letters are used, and can write the whole thing out in algebraic form if necessary.

If our arguments are sound, it follows that there is little to be said for the choice of subjects which are without utility of their own and without any value in developing the memory. It is perfectly obvious that one might be able to recite everything written by Homer—or the "other man of the same name"—backwards, while standing on one's head, without having the faintest comprehension of what was meant, and without even the intelligence of a parrot. That is memory of a sort. Ultimately it is identical, in every essential particular, with the dent of your boot on the leg of your table. An impression was made on your table and it retains it, but on the whole it is worth rather less than nothing.

Self-consciousness. If the psychologist were asked to name the distinguishing characteristic of man's mind, he would answer that it is self-consciousness—the recognition of himself. We may recall Tennyson's lines: "The baby new to earth and sky . . . . hath never thought that this is I." Now we may be all agreed that the lower animals have never "thought that this is I." Even in their highest psychical developments, whether in the ant or the beaver or the domesticated dog, animals can never be credited with self-consciousness. It is scarcely less than amazing to notice how confused are many people when first they come to consider this question. The muddle between consciousness and self-consciousness in popular psychology is like the muddle between will and free-will. In the latter case, those who declare that the will is not free in the old-fashioned sense, are constantly asserted to be declaring that the will does not exist at all. Similarly, when self-consciousness, or the recognition of the self, is denied to the lower animals, people often think that we are denying their possession of consciousness.

Difference between Man and the Animals. What, then, is the *differentia* between consciousness and self-consciousness? It is surely expressed in the words of the poet who says that man is "A being of a large discourse, looking before and after." The self-conscious being is one who has come to identify himself as an independent thinking being, who can recall the past, saying to himself, "I was there," and who may anticipate the future, saying: "That will happen to me." There is no evidence whatever that this faculty of looking before and after is to be found in any of the lower animals. While we cannot too strongly insist in these days upon the continuity of man with his inferiors in the animal scale, and while we know that comparative psychology is the key to many of the problems of human psychology, we must nevertheless frankly recognise and point out any distinguishing mark of man, wherever it is to be found. This is necessary, indeed, for our own credit. However highly animals may be trained—by means of the intervention of man's mind—there remains an almost immeasurable gap between the highest intelligence displayed by any animal, even if it be a genius among chimpanzees, and the average mind of man. Our psychology will be apt to be laughed at if, in our analysis of various types of mind, we are unable to point to any processes, in the case of man, which serve to explain the gigantic gap that separates him from his nearest relatives.

The Child's Beginnings. Of course, it is necessary for us to trace self-consciousness to its beginnings as far as possible. If we seek to find its germ in the lower animals, we meet with very little success. It is exceedingly difficult to find anything but the barest rudiments of this faculty in them. So we must turn to the developing human being; and it is an exceedingly interesting inquiry to begin with the baby, which has "never thought that this is I," and to trace the gradual development of the conception of self through its various stages. It is quite impossible here to go into such a difficult question at due length. Merely would we insist upon the peculiar importance of the study, since it concerns itself with, and therefore serves in some degree to explain, the development of that conception or faculty which is the *only unique mark of man*, and which is the necessary condition of all those other powers and achievements which distinguish him.

Two points we may note in order to appetise the reader to feed himself. The first is that the child begins by identifying its own body as an independent entity. Its recognition of the fact that its hand belongs to itself, in a sense that its toy does not, is comparatively early. It is much later that the child identifies its foot as its own property in this complete sense. Gradually, however, beginning with the hand, the whole body is identified as in a special sense a personal possession. And it is from this recognition that the recognition of the self springs later.

Personality. The second point we may note is that the recognition of the self is long preceded by a recognition of the personal identity of the child, though the child does not identify that person with himself. The consequence is that he speaks of himself in the third person. Long before he has learnt the use of I, and can say "I want this," he says, "Baby wants this." He has now gone so far as to recognise himself as an independent entity, but he has not yet come to identify the identity recognised with the self that recognises it. But after a time he ceases to act as his own spokesman, and in some dim, half-unconscious way he comes to accept for himself the doctrine of which Descartes made so much—*Cogito, ergo sum.* I think, therefore I am.

It would lead us too far afield to inquire into the various disorders and peculiarities which self-consciousness may display. It is obvious that we have begun to raise the whole conception of personality, and this would lead us, if we followed it, to the amazing changes of personality which result from the action of drugs and disease, and also to the whole question of multiple personality where, to the old-fashioned thinker, it would appear that several souls had united in one body—now one, now another—proclaiming itself as the sole occupant.

If Memory were Abolished. Our business here, however, is more properly with the normal mind, and the point on which we must insist is this, that the question of memory can never be divorced from that of self-consciousness. It is not by accident that we have passed from the consideration of one to that of the other. One can know oneself as oneself only, in virtue of past experience. We are self-conscious creatures simply and exactly because we are able to live in the past and the future as well as the present. But abolish all memory—abolish not merely your recognised and available knowledge, but abolish all memory whatsoever—the firmly organised memory of your nervous tissues in virtue of which you tend to have certain habits,

and all those memories which consist in modifications of your nervous tissue in consequence of past experience. What, then, will remain of your personality and your consciousness of self? These considerations are the key to the understanding of the mind diseased in many of its instances. We come to see how, in many curious changes of character, temperament, and personality, there has been tampering with the physical basis of memory, and that this is the key to the facts.

Self-consciousness and Internal Sensations. In considering the question of self-consciousness there is one practical matter which is of equal interest both to psychology and to medicine; and this is the part which the internal sensations play in self-consciousness. But we have insisted already in this course upon the importance of what may conveniently be called organic sensation. It is scarcely possible for us to conceive of ourselves at any moment except with some sort of conscious or unconscious appreciation of our state in terms of pleasure and pain. I say, for instance, "I am feeling very fit this morning," or "I am out of sorts," or "I am depressed," and so on and so on. The self is not only recognised as the self, but is recognised as having a particular state of well-being or ill-being, and ultimately all our acts are devoted—and this includes even our most unselfish acts—to the promotion of the well-being of the self. Now it is necessary here to insist that organic sensation plays a most extraordinary part in determining how far the self finds itself in a state of well-being or ill-being

We must further insist, in the strongest possible language, that the part played by organic sensation in this respect is out of all proportion to its intrinsic importance. Now this is not generally recognised except by the student who has seen mind on its abnormal side.

Optimism and Pessimism. Commonly, we assume that optimism and pessimism, the looking on the bright side of things or on their dark side, and, in general, the judgments of the optimistic philosophers like Leibnitz, or the later philosophers, Schopenhauer and Nietzsche, those appalling pessimists, are intellectual and rational conclusions of the unbiassed reasoning faculty. Now it may be a very materialistic comment, but it is nevertheless a mere platitude to those who are acquainted with the facts, that optimism and pessimism are very largely matters of digestion. That is the crudest way of putting it. In more general terms we may say that the whole vague and apparently negligible mass of sensations which reach us from the interior of our bodies influence the consciousness of self so as to make the self appear happy when one is in good health. But in the course of a very large number of disorders, ranging from the most trivial indigestion to the gravest and most permanent disease of the brain, these organic sensations may be modified with the most astonishing consequences. In one series of cases the self is raised to a state of preposterous exaltation. A dying pauper, his whole body riddled with disease, may be perfectly happy, and more than perfectly happy, imagining himself to be the Duke of Wellington or the Maker of all things, and writing cheques for millions where he has not a halfpenny. Such may be the influence of disordered organic sensation upon the self, or, if you please, upon the self's conception of itself.

In another series of cases, where every possible circumstance makes for happiness, where the patient may have a joyful and reassuring creed, friends, ease, and honour, his self is in a state of permanent misery. Familiar to all is the instance of poor Cowper. Organic sensation in such cases is disordered—whether in the terminals of the nerves in the organs or in the nerve-cells themselves in the brain, does not matter. The point is that in both classes of case the state of the self, biassed in one direction by what would appear to be an overwhelming number of external causes of the most potent kind, and biassed in the other direction by a mere vague group of organic sensations which cannot even be identified in consciousness, is irresistibly determined *by these last*, so that with every external cause for despondency and despair and even self-disgust, the self may be radiantly happy, while with every external cause for happiness, the self may yet be plunged in the very Inferno of despair.

The Mind is a "Whole." It is not possible to arrange psychology in such a simple fashion as one arranges chemistry, for instance, when considering one group of elements after another. For the mind, which is our object of study, is a *whole*. Nevertheless, we are proceeding on a definite plan. Proceeding from sensations and the immediate consequences of sensations in compelling the attention and in leading to action, we discussed the process by which the sensations of the past can be recalled in the present or, if not definitely recalled, can, at any rate, play their part. We went on to show that their principal part—and this applies to all memories, not merely those of simple sensations—is found in their providing the possibility of self-consciousness, and the making of a being who looks before and after. We then proceeded to show how the attitude of this being to existence is determined partly by his past experience, partly by his memories, but also, and in a most remarkable degree, by present sensations which do not form part of his experience in the ordinary sense, since they have nothing to do with the world around him—animate or inanimate—but depend upon his own internal constitution. Then we saw how the influence of these internal sensations may be directed so as to cause a man to be at the one extreme an optimist, and at the other a pessimist. This leads us to the extremely important matter of the psychological analysis of optimism and pessimism—a matter of great practical importance, and greatly neglected. When we have considered it as fully as space allows, we shall be prepared for a better understanding of one of the great subjects of psychology—namely, pleasure and pain.

Continued

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MINING AND QUARRYING

The Importance and Development of Mining and Quarrying. Mineral Deposits: Their Location and Characteristics. Tools for Prospectors

By D. A. LOUIS

MINING and quarrying are those industries which have for their object the extraction of useful minerals from the crust of the earth. It is particularly significant that by means of capital and labour they create wealth by rendering useful and marketable materials which are unproductive and unremunerative as long as they remain undisturbed in the earth. They are of extreme antiquity, and are alluded to directly or indirectly in the Bible and other ancient records. In fact, their influence on civilisation has been remarkable, and there is very little doubt that the progress of the human race has always advanced hand in hand with the better utilisation of the products of the mineral kingdom, or, in other words, with the fruits of mining and quarrying. This is true from the most ancient times to the present day. Archeologists even classify the past periods of human existence as the Stone Age, the Newer Stone Age, the Bronze Age, and so on, gauging the advancement of humanity by the better use it made of mineral products.

Why are Mining and Quarrying Important? The reason for their importance is not far to seek, for do not mining and quarrying provide the sinews of warfare in the form of coin, and the bone and muscle as well in the form of fortifications and warships, guns and ammunition, all mainly of mineral origin, leaving, so to speak, the nerves, brain, and flesh of warfare to the animal and vegetable kingdom? Fighting is here placed first because we are always fighting something or somebody. Moreover, a good fighter can mine and quarry or do anything else in peace.

The position of these industries in peaceful occupations is, however, equally well attested, for they provide material for our buildings, for our means of communication—roads, railroads, or ships—for our fuel, for our machinery, and what not. In fact, one of the few things we do not do with minerals is to devour them in bulk, although we consume them plentifully in the form of mineral waters, medicines, and with and in our food.

1. VEIN FORMATION

The object of mining and quarrying is, and always has been, to supply the world with its mineral requirements. In achieving that, they give, and have given, employment to vast numbers of people and to immense amounts of money, both, when expressed numerically, going into many many millions, and both always on the increase. In our own country, in 1904, there were 877,057 people employed in mines and 97,577 in quarries, and minerals of the value of £97,477,639 were produced. The mere existence of mineral wealth in a district is not sufficient; it must be mined or quarried to be turned to account. Moreover, the demands for mineral products is so great that deposits are constantly being sought in all parts of the world, and wherever and whenever possible, are worked as a result.

What Mining and Quarrying Produce. The significance of mining and quarrying will perhaps even be better appreciated when some of the varied products are mentioned. They include the ores from which are obtained the well-known metals: gold, silver, copper, iron, lead, zinc, tin, quicksilver, and the lesser-known metals, manganese, nickel, cobalt, aluminium, arsenic, antimony, bismuth, chromium, platinum, tungsten, vanadium, uranium (radium), etc. They include also precious stones, ornamental stones, building stones, millstones, grindstones, oilstones, whetstones, slates, and such like; the fuels and allied minerals: coal, peat, ozokerite, petroleum, natural gas, oil-shale, jet, graphite, bitumen, asphalt, amber, etc.; clays of different kinds for pottery, for earthenware, for brickmaking, etc.; gravel, chalk, cement, gypsum, bauxite, felspar, flint, fluorspar, fullers' earth, lime, marl, pumice, ganister, sand, etc; attritive material, such as emery, quartz, garnet; chemical substances, such as alum, bromine, iodine, barytes, borax, potash, soda, potassium salts, pyrites, saltpetres,

strontium, sulphur, monazite, common salt, etc.; pigments, mineral waters, carbonic acid, phosphates, and such sundries as asbestos, infusorial earth, mica, talc, and rare earths.

The useful minerals we produce in our own country include the following: alum shale, arsenical pyrites, barytes, bauxite, chert and flint, clay and shale, coal, copper ore, copper precipitate, fluorspar, gold ore, gravel and sand, gypsum, igneous rocks, iron ore, iron pyrites, lead ore, limestone, manganese ore, mica, natural gas, ochre, umber, oil-shale, phosphate of lime, salt, sandstone, silver ore, sulphate of strontia, tin ore, uranium ore, wolfram and zinc ore. It will be seen that civilisation would indeed be quite impossible without many of the products of mining and quarrying.

2. WORKINGS IN MIOCENE LIGNITE AT BOVEY TRACY, DEVONSHIRE
(Geologist Association, London)

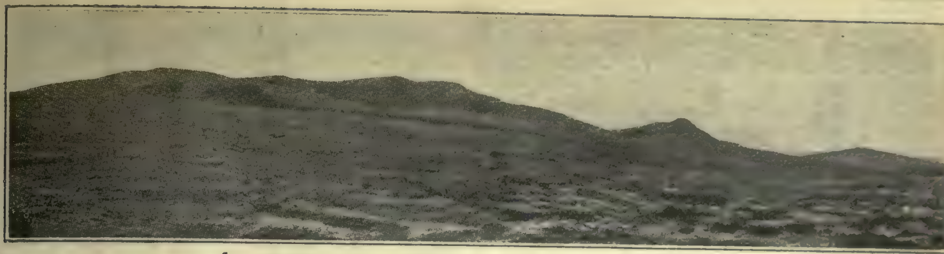
Information about these products has already been furnished and is accessible to the reader in the courses on Building, Materials and Structures, Geology, Chemistry, etc., so do not call for repetition here.

Extent of the Mining Field. The entire world is the field of mining operations; in fact, to the workers in these industries we owe the discovery of many new places, the development of many countries, the foundation of townships, and the establishment of whole communities. This was true in the days gone by, and is true now. Many towns in Western America owe their existence and wealth entirely to mining enterprises; the same is true of Australia, of New Zealand, and South and West Africa. In fact, had the few square miles of territory in the Transvaal been merely agricultural country, and not gold bearing, there would have been no vast accumulation of peoples of different nations, no South African War, and no Chinese labour question for the 1906 electorate. Mining, too, is not restricted to any particular zone; the torrid zone, the two temperate zones, and even the Arctic zone are invaded by the intrepid workers in these industries. In fact, many populous regions in the world would be supporting a very scanty population, or even none at all, were it not for mining and quarrying operations.

The man who adopts mining for a livelihood should have no aversion from adventure and travel, for it would be difficult indeed to find a country where mining or quarrying operations of some sort are not in progress. In connection with these industries it may well be said that the world is their field.

The Scene of Activity. The crust of the earth is the region of the miners' and quarrymen's activity where they do their delving and digging; but, again, the courses on Geography and Geology have dealt so fully with this subject that here it is neccessary

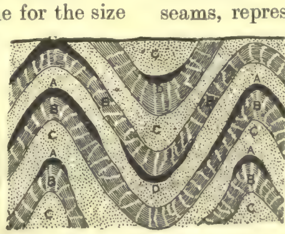
3. PIT IN LIAS BEDS, RUGBY CEMENT WORKS, SHOWING FOLDED STRATA
(The Geological Survey)



4. OUTCROP OF IRON ORE, KIIRUNAVAARA, LAPLAND

only to make a passing reference to this part of our subject. In the course on Geography it has been demonstrated that the solid outside or crust of the earth, although only a very insignificant proportion of the whole mass of the earth, is very diversified in configuration, here rising into mountains, there sinking into immense basins and valleys, some filled by the ocean, some by inland seas and lakes. The study of geology has shown that this crust is made up of different kinds of rocks, some of which consist of material that has cooled down from a molten state and are called *igneous* rocks, others consisting of material that has been deposited from water in layers, and are called *sedimentary*, *stratified*, or *aqueous* rocks, while others again, consisting of igneous or sedimentary rocks altered in the mass, are called *metamorphic* rocks. These rocks, it has been shown, have been subjected to various powerful agencies throughout immense periods of time, and have not only been worn away, dislocated, shifted, and tumbled about, but have become jointed, cracked, fissured, crushed, crumpled, folded, and what not. These disturbing influences have, in fact, given rise to the various irregularities of the crust of the earth, including the mountains, valleys, ravines, plains, and faults. Many examples of this will be encountered in subsequent figures, but 3 furnishes a very good example of folding, with the anticline at A B C, and the synclinal basin at D. The men at E and F furnish a scale for the size of the banks, while the surface at G H shows how denuding agencies have worn down these beds to an almost dead level at the surface.

Location of Mineral Deposits. Where are useful minerals found in the crust of the earth may well be the next question. They are in some cases found constituting the entire mass of stratified, igneous, and metamorphic rocks, but they form in other instances mere deposits in such rocks. They are found throughout the whole series of geological ages from the Archæan to the most recent, although certain valuable mineral deposits do affect certain areas and certain associations. Finally, they may be found in the mountain, in the valley, in the plain, and even below water. And the deposits are called according to their character and position—*alluvial* deposits, *beds* or *seams*, *veins* or *masses*.

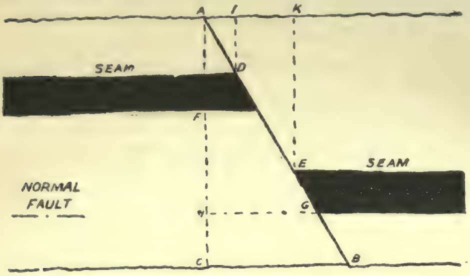


5. BENDIGO SADDLE REEF
(B. H. Brough)

Alluvial Deposits. Alluvial deposits are those found filling up the bottoms of ancient or modern river valleys, and consist of the waste material which has been carried down by rivers and deposited wherever or whenever the current became sluggish. They consist of irregular layers of gravel, sand, clay, interspersed with organic detritus, pebbles, and even boulders. Sometimes only one of these materials prevails, sometimes two or more of them. The gravel pits in the Thames Valley, the tin deposits of the Red River in Cornwall, the gold placers of California, New Zealand, and Western Siberia are examples of such deposits, of which a vast number occur in different parts of the world.

Beds or Seams. A bed or seam is simply a special member of a group of stratified rocks; it therefore partakes of the characters of stratified rocks [see GEOLOGY], may be horizontal, inclined, folded, or faulted. It may extend in length and breadth for thousands of yards, or may be confined to a restricted area. It may be uniformly a few inches or many feet thick, or it may vary considerably in thickness, dwindling away gradually in one part, while increasing in size in another. A bed may even be split into two or more seams by the interstratification of some *parting* or worthless rock. Seams are also occasionally interrupted and altered by the intrusion of igneous rocks; the whin-sill in Northumberland is an example of this kind of disturbance. At other times gaps occur in seams, representing the bed of an ancient river; these are known as *wash-outs* or *dumb-faults*. But, in spite of these irregularities, a bed is much more uniform in thickness and composition than a vein. As in the case of other stratified rocks, the direction of its length is called the *strike*, and the direction of its breadth or inclination the *dip*. The bed immediately above is known as the *roof*, and the one below it as the *floor*. In the photograph of a stratified deposit [2] the strike of the beds is across the figure, and the dip is away from the spectator, and in reference to the seam of light material B, A is the roof, and C is the floor. In 3 it will be seen that the same beds may dip in opposite directions as at the positions A and C. One of the most useful characters of seams and beds from a mining and quarrying point of view is the system of *joints* in three different planes so

common in stratified rocks. The great coalfields of America that stretch for thousands of square feet nearly horizontally, the restricted coalfield of the Forest of Dean, the faulted coalfields of Belgium, and the nearly vertical coal seams of the St. Etienne district in France, are all, as well as all other coalfields, examples of bed or seam deposits. So, too, are all limestone, sandstone, chalk, slate, and such deposits ; as well as the smaller bands of iron ore, of brick earth, and of some other materials included in the list of useful mineral deposits.

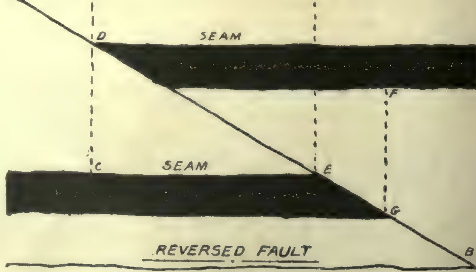


6. DIAGRAM OF NORMAL FAULT

Veins, or Lodes. Veins, or lodes, are deposits that take a tabular or sheetlike form, and extend with more or less verticality into the ground, the material in them being different to that of the surrounding rock [1B]. They may extend into the ground to a great depth or be quite shallow ; they may stretch across country for miles, either availing themselves, or not, of any natural divisions of the rocks in which they occur. They may occur in any kind of ground, but are more frequently encountered in the older stratified rocks, in metamorphic and in igneous districts, than in the newer stratified formations. They may vary in width or thickness from a few inches to many feet even in the same deposit. The contents mostly form a more or less confused mass, although there is always a certain amount of regularity of distribution ; but frequently they form two or three or even several more or less continuous sheets of distinct minerals, such, for instance, as quartz, fluorspar, calcite, blende, galena, pyrites, and suchlike, which run parallel with the length and breadth of the vein, and consequently give such veins in cross-section a banded structure or appearance. In a district where veins occur there are generally several veins running more or less parallel, and others, again, running in a different direction ; the latter are known simply as *faults* or *cross courses* if they are not mineralised—that is, if they contain only worthless minerals. If, however, they are mineralised, they are called *counter veins*.

Different Forms of Veins. However, it must always be remembered that all veins are fissures or cracks that have become filled up. Veins that penetrate deeply into the ground and take a strong course across country are called *fissure veins*. When, on the contrary, the vein goes only a little way into the ground and does not extend far or strongly across country, it is known as a *gash vein ;* when the rocks on each side of the veins are different, the vein is known as a *contact vein*, and when the vein is not mineralised it is known as a *barren vein*. The rock through which the vein runs is known as the *country*, or frequently as the *country rock*. The direction that the vein takes across country is known as the *strike*, and the direction that it takes into the ground the *dip* when compared with the horizontal, but the *hade* or *underlie* when the inclination is compared with the vertical. Both the strike and dip may vary in direction within a few feet, so that although in the long run they have a general direction, the course is often irregularly serpentine in case of the strike, and somewhat choppily wavy in the case of the dip. The containing sides are known as the *walls*, the upper one as the *hanging wall* [1A], the under one as the *foot wall* [1C], and owing to vagaries of dip occasionally the foot wall may for some distance be really a hanging wall, or the reverse may be the case, but to avoid confusion the original names should be adhered to. The thickness of a vein is measured on a line ttaken at right angles to the walls across the vein.

Vein Formation. Veins are not filled solely with useful minerals or ore, for more frequently than otherwise the accompanying minerals known as *vein-rock, vein-stuff, matrix* and *gangue* are worthless, and constitute the preponderating part of the filling. Frequently, too, a layer of clay, known as *selvage* or *gouge*, lines the inside of the walls of veins, while another intruder in veins occasionally encountered, and known as a *horse*, consists of a piece of the country that has fallen in during the period of filling, and has become included in the contents ; this may be quite small and inconsiderable, or very large, and measure many feet high, many feet thick, and many feet long. It is noteworthy that the



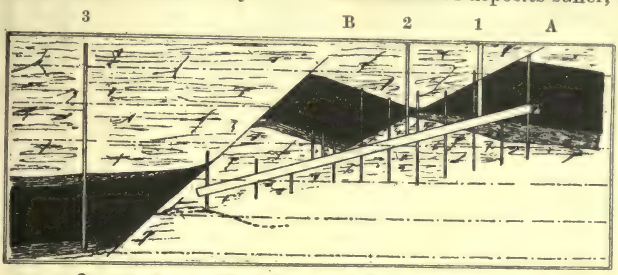
7. DIAGRAM OF REVERSED FAULT

mineralisation or content of useful mineral in a vein is far from regular. In places it may be rich, even very rich, and elsewhere it may be poor, or even barren ; and what is worse, may thin down and die out, or *pinch* out, as it is termed. Fortunately, however, the rich parts often prevail for some distance, both on strike and dip ; and according to the fancy of the miner, and the configuration and richness and extent of the rich area, it is called a *bonanza*, a *shoot*, a *pocket*, a *bunch*, a *pipe*, a *chimney*, a *course of ore*, and even other fanciful names.

Another feature associated with veins is the occurrence of smaller veins, which appear sometimes to run into, and sometimes to branch from, the main veins and are known as *leaders, branches, feeders, droppers, strings.* In some cases, again, useful mineral is contained in a network of small veins which intersect the country or the vein-rock at all angles, forming what are known as *stockworks*, which about form the border line between masses and veins.

To obtain a good idea of a vein, two sheets of slightly crumpled paper should be held steeply inclined and parallel to one another, so as to leave a space between them; then imagine this space filled with vein-rock, etc., and the space beyond the pieces of paper to be the country. The upper sheet of paper would represent the hanging wall, the lower one the foot wall, the inclination the dip or hade, and so on. The crumplings would serve to demonstrate the local variations in thickness, dip, and strike.

Masses. Masses of useful minerals may consist of great bosses of metamorphosed or igneous rock, such as many of the deposits of basalt, granite, syenite, etc., so extensively quarried for building purposes and road making, and masses of marble; or they may consist of small or large accumulations of useful mineral filling joints and cavities in rock, such as the iron ore deposits of Cumberland. Or, again, they may consist of stratified or unstratified rocks, simply mixed with or impregnated with useful mineral. The copper bearing slates of Mansfeld, in Germany, and the lead ore deposits of Mechernich, in Prussian Rheinland, are examples of such masses in stratified rocks; while the tin capels in Cornwall are examples of them in unstratified rock. The famous saddle reefs of Bendigo, Victoria, may be regarded as forming the border line between masses and bedded deposits. These are illustrated in **5**. They occupy fissures that, owing to the bedding of the strata, have assumed a shape that in cross-section has the appearance of a saddle. The enclosed rocks B and C are contorted slates and sandstones of Lower Silurian age. The reefs are shown at A and D. In fact, in the distribution of the useful material, and in general character, masses are, like beds and seams, more regular than veins, but their magnitude is uncertain.



8. FAULTED SEAM IN A BOHEMIAN COALMINE

Outcrop. The *outcrop* is that part of any deposit which reaches the surface, whether it be on a hill, in a valley, or cliff face. The outcrop shown [**4**] is a striking feature in the otherwise flat country, and forms the crowning ridge of a range of hills about three miles long.

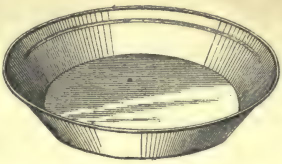
Deposits Vary with Character of the Country. The character of the country occasionally exerts a marked influence on the character of the contents of a vein or mass, and in some cases a change in country is accompanied by a change in the structure of a vein. In the Alston Moor district in Cumberland, for instance, the veins of lead ore pass through beds of limestone, sandstone, and shale, and are usually more productive in the limestone than in the sandstone or shale. In Derbyshire, the lead deposits are productive in the limestone, but rarely yield ore in the inter-bedded igneous rock, locally known as *toadstone.* In Cornwall, the veins in the clay-slate, or killas, bear chiefly copper, while the same veins in granite below carry tin. At Wortherton mine, in Shropshire, the deposits of barytes can be worked where the adjacent rock is volcanic ash, but are valueless in the shale country of the district. The *kindness* or otherwise of the country, moreover, is a very important factor in the working.

Faults in Seams. Of all the troubles that useful mineral deposits suffer, faults are the most common and most aggravating. Faults affect the useful deposits in exactly the same way as they affect other deposits dealt with in the Geological course, and therefore we need consider them solely from a mining point of view. Only the simplest cases, which also are those most frequently encountered, can be considered here; *step faults* and *trough faults*, etc., are of rarer occurrence. A bed or seam is said to be *thrown* when displaced by a fault, while a vein is *heaved*, the displacement being more or less vertical in the former, and lateral in the latter case. When a fault is encountered in working a seam, it is recognised by the sudden termination at a wall of other rock; the point of contact first observed should be carefully noted, and if the interruption be first detected in the roof, and slant away towards the floor, the throw is most likely a *down-throw*, and the continuation of the seam on the other side of the fault would be found by cutting through the fault and conducting exploratory operations downwards. The contrary condition of things would indicate an *up-throw;* then the exploratory operations would be directed upwards. Boring comes in useful for this purpose. If the seam is not found within a reasonable distance, a reversed fault may be the cause of the trouble, and the exploratory operations would be conducted to test this point.

In the diagrams **6** and **7** the properties of faults are set forth; AB is the fault in each case. In **6** the angle CAB is the hade of the fault, FH is the throw or vertical displacement, IK is the width of the fault or horizontal displacement or shift; in this area a shaft sunk would meet with no

coal; it is known as the *want*. Approached from the left this fault would be a down-throw; approached from the right it would be an up-throw. DE is the slip or the displacement on the incline. In the reversed, overthrust or overlap fault [7] the angle CDE or IED is the hade of the fault AB, FG or DC the vertical displacement, DE the overthrust; HI is the horizontal displacement, and a shaft sunk within this area would encounter the seam twice; it is hence known as the *repeat*.

In 8 is shown an actual occurrence encountered in a coalmine in Bohemia. The fault was first observed in working the seam on the right, where the end of a level is shown. Boreholes Nos. 1, 2, and 3 were successively put down, and the hade of one of the faults, A (for there are two of them—step faults, in fact) as well as the position of the continuation of the seam, determined. Then the inclined drivage indicated was made, starting from the level on the right, boreholes being put out at intervals, as shown, to investigate matters further. These boreholes disclosed the position of the intermediate portion of the seam, and, by means of the last upward borehole from the inclined drivage, the existence of the second fault, B. From left to right the faults are up-throws; from right to left down-throws. The throw of the first is 15 ft., of the second over 100 ft.; the slip 60 ft, and 140 ft. respectively, and the shift a few feet and 50 ft. The incline as shown is 285 ft. long.

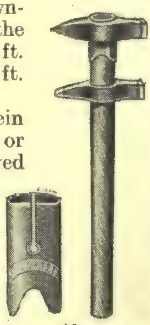


9. PAN FOR GOLD WASHING

Faults in Veins. In the case of a vein the angle that the vein makes with the fault or cross-course should always be carefully observed and in most cases the continuation of the vein will be found on the side of the greater angle. In 6 the angles the seam makes with the fault at L and E are greater than those at D and G. Various investigators have studied the question of faults, and one of these, Zimmerman, has laid down the following rule for finding the vein on the other side of a fault. The line of strike of the fault is set down upon paper, and the horizontal projection of the line of intersection is ascertained by construction, and from the point where the fault is met by the lode a line at right angles to the fault is drawn towards its opposite wall. Then, after cutting through the fault, the continuation of the lode is to be sought on that side of the line of intersection that this perpendicular falls.

Points about Faults. The heave of a vein is called right-hand or left-hand, according to the position of the heaved portion of the vein. It will be observed that the term up-throw, down-throw, right-hand heave, left-hand heave, are simply relative terms, for a right-hand heave approached from the other side becomes a left-hand heave, and a down-throw in the same way becomes an up-throw. Pieces of cardboard fitted together at different angles and inclinations may advantageously be used to study the effects of faults on veins. Having now learnt something about the character and peculiarities of valuable mineral deposits, the methods used to discover them may next be considered.

Prospector's Equipment. The equipment for purposes of discovery is a matter for serious consideration, as it is extremely important not to be over-burdened with impedimenta. The outfit, however, should include a pick, a small chisel or gad, a hammer [10]—the pick and hammer can be combined in one implement—a spade, a shallow circular iron dish with sloping sides called a pan [9], a pocket lens, a pocket-knife, a magnet, a clinometer, a compass—or better still, a clinometer and vertical angle scale combined with a prismatic compass—a tape or steel band measure, and a foot-rule; while small bags for holding specimens, and pockets, or a larger bag in which to carry them, are indispensable. It is well to have a blow-pipe set with reagents, and a set of minerals for testing hardness, accessible in the camp if not in the field; and in many instances a balance and weights are useful. Of course pencils, pens, and notebooks are essential; if the latter are of squared paper they are particularly useful for sketching to scale.



10. PROSPECTOR'S HAMMER (Hardy Pick Co.)

Use of the Appliances. The pick serves for breaking ground, the hammer for smashing and crushing lumps, the chisel or gad for working out fossils or minerals, the spade for handling the broken material, the pan for washing crushed material, sand, or loose dirt, etc. For the last-mentioned purpose the dirt is put into the pan and mingled with water, a swinging and circular motion is given to the pan so as to cause the whole sloppy magma to swirl round, and by repeatedly washing away the lighter matter off the edge, only the heavier matter containing the valuable material remains, and can be estimated and examined with the pocket lens and magnet, and if reagents and blowpipes are available may be further tested. The pocket lens and hardness set serve for examining lumps of rock for useful minerals, and isolated minerals themselves. The compass and other instruments serve for finding the way and observing the direction of strikes, dips, etc., while hade or dip can be measured by the clinometer. A very considerable amount of information can be obtained by the adroit use of these few simple appliances.

Continued

ALGEBRAIC EQUATIONS

Simple Equations. Definitions. Simultaneous Simple Equations of the First Degree containing Two and Three Unknown Quantities

continued from page 2282

By HERBERT J. ALLPORT, M.A.

SIMPLE EQUATIONS

43. An *equation* states that two algebraical expressions are equal. The two expressions are called *sides* of the equation.

If, however, the two expressions are equal for *all values* of the letters involved, the equation is generally called an *identity*. The name *equation* is applied to the cases in which the expressions are only equal for some particular values of the letters involved.

For example,

$$(x + a)(x + b) = x^2 + (a + b)x + ab$$

is an identity, since these two expressions are always equal whatever the values of x, a, and b may be.

$$3x + 7 = 2x + 9$$

is an equation, since the two expressions $3x + 7$ and $2x + 9$ are only equal in the particular case where $x = 2$.

44. In the latter example, x is called the *unknown quantity*. The process of finding the value, or values, of the unknown quantity for which the equation is true is called *solving* the equation. These values are called the *roots* of the equation, and are said to *satisfy* the equation.

It is usual to express unknown quantities, whose values have to be found, by letters from the *end* of the alphabet, x, y, z. Quantities whose values are supposed to be known are represented by letters from the *beginning* of the alphabet, a, b, c.

45. If equations contain only the *first* power of the unknown quantities they are called *simple* equations, or equations *of the first degree*.

We shall first consider equations which contain only one unknown quantity.

Suppose we have to solve the equation

$$4x - 3 = 2x + 7. \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Since these two expressions, $4x - 3$ and $2x + 7$, are equal, the results obtained by subtracting $2x$ from each of them will be equal.

Therefore

$$4x - 3 - 2x = 2x + 7 - 2x\,;$$

or,

$$4x - 3 - 2x = 7.$$

Again, if we now add 3 to each side of the equation, the two sides will still be equal.

Hence,

$$4x - 3 - 2x + 3 = 7 + 3\,;$$

or,

$$4x - 2x = 7 + 3. \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Compare the result (2) with the original equation (1). Each contains the same terms, but in (2) the terms which contain x are on one side of the equation, and the numerical terms are on the other. Also, we see that the term $2x$ in (1) is on the right, and is +, while in (2) it is on the left and is −. Similarly, −3 on the left of (1) becomes +3 on the right of (2). That is, *we may move a term from one side of an equation to the other, provided we change its sign.* A term which is moved from one side to the other is said to be *transposed.*

If we now collect the terms on each side of (2) we get

$$2x = 10\,;$$

and it is clear that if we divide equal quantities by the same quantity, the quotients will be equal. Hence, we now divide both sides of the equation by 2, and obtain the result $x = 5$.

46. The essential part of the process, then, is to put all terms which contain the unknown quantity on to one side of the equation, and all other terms on to the other side, remembering that when we transpose a term we must change its sign. We then collect the terms on each side of the equation, and, finally, divide both sides by the coefficient of the unknown quantity.

Very often, however, the equation requires some simplification before we are able to transpose the terms, as will be seen from the following examples:

Example 1. Solve $4(x - 3) - x = 2(x - 1)$.

Here we must first remove the brackets.

Thus,

$$4x - 12 - x = 2x - 2.$$

Transposing,

$$4x - x - 2x = -2 + 12.$$

Collecting terms,

$$x = \underline{10 \ \textit{Ans.}}$$

The student can always *verify* his results—*i.e.*, test whether the value found does satisfy the equation—by substituting the value in both sides of the equation.

Thus, in Example 1, if we put $x = 10$ in the left side of the equation, we obtain

$$4(10 - 3) - 10, \text{ which equals } 18.$$

Again, putting $x = 10$ in the right side of the equation we get $20 - 2$, or 18. Since the two results agree, we know that the solution is correct.

Example 2. Solve

$$\frac{x+1}{2} + \frac{2x-3}{3} = 5 - \frac{3x-1}{4}.$$

It is evident that if the sides of the equation are equal, the products obtained by multiplying both sides by the same quantity will be equal. We multiply all through by 12, the L.C.M. of the denominators 2, 3, 4, and thus get rid of the fractions.

For $\frac{12(x+1)}{2}$ equals $6(x+1)$,

$\frac{12(2x-3)}{3}$ equals $4(2x-3)$,

and so on.

Hence, the working of our equation is written out as follows,

Clearing fractions,

$$6(x+1)+4(2x-3)=60-3(3x-1),$$

or,

$$6x+6+8x-12=60-9x+3.$$

Transposing,

$$6x+8x+9x=60+3+12-6.$$

Collecting terms,

$$23x=69.$$

Dividing by 23,

$$x=\underline{3\ Ans.}$$

With a little practice, the fractions are cleared and the brackets removed in the same process. The chief point to remember is that if a fraction has the sign $-$ before it, the signs of the numerator must be changed when we clear the fractions. For instance, in the above $5-\frac{3x-1}{4}$ became $60-9x+3$, *not* $60-9x-3$.

Example **3**. Solve

$$a(x+b)+b(x-a)=a^2-b^2.$$

Removing brackets,

$$ax+ab+bx-ab=a^2-b^2.$$

Collecting terms,

$$(a+b)x=a^2-b^2.$$

Divide by $(a+b)$, the coefficient of x; then

$$x=a-b\ \underline{Ans.}$$

Example **4**. Solve

$$(x+1)(x+3)+(x+2)(x+4)=2(x+3)^2.$$

Removing brackets, Art. **31**,

$$x^2+4x+3+x^2+6x+8=2x^2+12x+18.$$

Transposing,

$$x^2+4x+x^2+6x-2x^2-12x=18-3-8.$$

Collecting terms,

$$-2x=7.$$

Dividing by -2,

$$x=-\underline{3\tfrac{1}{2}\ Ans.}$$

EXAMPLES 7

Solve the following equations :

1. $5(2x-1)-3(x+4)=3(x-3)$.
2. $3(1-x)-2(3+5x)+x=0$.
3. $\frac{x}{2}-\frac{x}{3}=2$.
4. $\frac{1}{2}(x-2)-\frac{1}{3}(x+4)=\frac{1}{6}(5x-2)$.
5. $3(x+1)^2+4(x-3)^2=7(x-1)^2$.
6. $\frac{x+\frac{1}{4}}{2}-\frac{3x-\frac{1}{4}}{4}=\frac{x-\frac{3}{4}}{3}$.
7. $5x-\{6-2(2x-3)-x\}=2(1-2x)$.
8. $(x+a)^2-(x+b)^2=(a-b)^2$.
9. $\frac{a}{x}+\frac{b}{x}=c(a+b)$.
10. $(x+a)^3+(x+b)^3+(x+c)^3=3(x+a)(x+b)(x+c)$.

SIMULTANEOUS SIMPLE EQUATIONS

47. So far, our equations have only contained *one* unknown quantity. If an equation contains *two* unknown quantities, we can find as many pairs of values of the unknown quantities as we please which will satisfy the equation.

For, consider the equation

$$2x-3y=2.$$

From this we see that $2x=3y+2$, and therefore $x=\frac{1}{2}(3y+2)$. Hence, if we give y any value we please, we obtain a corresponding value for x.

Similarly, if we have a second equation, containing the same unknown quantities x and y, such as

$$x+3y=10,$$

we know that $x=10-3y$, and we are again able to find as many pairs of values of x and y as we please which will satisfy the equation.

But, if both equations are to be satisfied by the *same values of x and y*, then the two expressions $\frac{1}{2}(3y+2)$ and $10-3y$ must evidently be equal.

Thus

$$\tfrac{1}{2}(3y+2)=10-3y,$$

and, if we solve this equation by the methods of Art. **46**, we find that $y=2$. Therefore, since we know that $x=10-3y$, we have $x=10-6=4$.

Hence we see that if the equations

$$2x-3y=2$$
$$x+3y=10$$

are to be satisfied by the *same* values of x and y, the only solution possible is $x=4$, $y=2$.

48. Two or more equations which are to be satisfied by the same values of the unknown quantities are called *simultaneous equations.*

The *degree of an equation* containing two unknowns, x and y, is the degree of that term which is of the highest dimensions in x and y. [Art. **29**.]

Thus,

$2x-3y=2$, is of the *first* degree.

$3xy+4=10x$, is of the *second* degree.

Similarly, if there are three unknowns, x, y, and z, the term of highest dimensions in x, y, and z determines the degree of the equation; so that $x+2y+3z=0$ is of the first degree, and $ax^2+byz=cx$ is of the second degree.

49. For the present we shall only consider equations which are of the first degree. We shall see that to find the values of *two* unknowns we require *two* equations, to find *three* unknowns we require *three* equations, and so on.

Example **1**. Solve the equations,

$$4x-3y=18. \quad . \quad . \quad . \quad . \quad (1)$$
$$3x+2y=5. \quad . \quad . \quad . \quad . \quad (2)$$

For the sake of reference it is convenient to number our equations.

Our object must be to form an equation, by the aid of (1) and (2), in which either the x or the y is wanting. The process by which we do this is called *elimination*, and the unknown quantity thus got rid of is said to be *eliminated*.

Suppose we eliminate y. In (1) the coefficient of y is 3, in (2) it is 2. The L.C.M. of these coefficients is 6. We can, therefore, by multiplication, make 6 the coefficient of y in each equation. Hence, multiply (1) by 2, and (2) by 3, and we get

$$8x - 6y = 36. \quad . \quad . \quad . \quad . \quad (3)$$
$$9x + 6y = 15. \quad . \quad . \quad . \quad . \quad (4)$$

It is clear that if we now *add* the corresponding sides of the equations (3) and (4) we shall eliminate y.

Thus,

$$17x = 51.$$

Therefore, dividing by 17, we have

$$x = 3.$$

We can eliminate x in a similar way from the equations (1) and (2) and so obtain the value of y. Or, knowing the value of x, we can substitute this value for x in either (1) or (2), which is often a simpler elimination than the other.

Substituting the value of x in (1), we have

$$12 - 3y = 18.$$

Therefore,

$$3y = 12 - 18$$
$$= -6$$

so that,

$$y = -2.$$

Thus, the required solution is $x = 3$, $y = -2$.

Example **2**. Solve the equations

$$\tfrac{1}{3}(x-1) = \tfrac{1}{4}(y+1). \quad . \quad . \quad . \quad (1)$$
$$\frac{2x-3}{5} + \frac{2y-13}{7} = 0. \quad . \quad . \quad . \quad (2)$$

We must first clear the fractions, as in Ex. **2**, Art. **46**, and transpose the terms. Thus,

Multiply (1) by 12,

$$4x - 4 = 3y + 3.$$

Therefore,

$$4x - 3y = 7. \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Multiply (2) by 35,

$$14x - 21 + 10y - 65 = 0.$$

Therefore,

$$14x + 10y = 86. \quad . \quad . \quad . \quad . \quad (4)$$

We now solve the equations (3) and (4) just as we did Ex. **1** above. Multiply (3) by 10 and (4) by 3, and add.

Then,

$$40x + 42x = 70 + 258\,;$$

or,

$$82x = 328.$$

Therefore,

$$x = 4.$$

Substitute this value in (3).

Then,

$$16 - 3y = 7,$$
$$-3y = -9.$$

Therefore,

$$y = 3.$$

We thus have

$$\left.\begin{aligned} x &= 4 \\ y &= 3 \end{aligned}\right\} \text{ Ans.}$$

Example **3**. Solve

$$(b+c)\,x + (b-c)\,y = 2ab. \quad . \quad . \quad . \quad (1)$$
$$(c+a)\,x + (c-a)\,y = 2ac. \quad . \quad . \quad . \quad (2)$$

We eliminate y in exactly the same manner as before.

If we multiply (1) by $(c-a)$ and (2) by $(b-c)$ the coefficient of y will become $(b-c)(c-a)$ in each case.

Hence, multiply (1) by $(c-a)$ and (2) by $(b-c)$ and subtract.

Then,

$$\{(b+c)(c-a) - (c+a)(b-c)\}\,x = 2ab\,(c-a) - 2ac\,(b-c).$$

Therefore,

$$\{bc - ab + c^2 - ac - bc - ab + c^2 + ac\}\,x = 2abc - 2a^2b - 2abc + 2ac^2.$$

Collecting terms,

$$2\,(c^2 - ab)\,x = 2a\,(c^2 - ab).$$

Dividing by $2\,(c^2 - ab)$,

$$x = a.$$

Substitute the value of x in (1).

Then,

$$(b+c)\,a + (b-c)\,y = 2ab.$$

Therefore,

$$(b-c)\;y = 2ab - ab - ac,$$
$$= a\,(b-c)$$

Dividing by $b-c$,

$$y = a.$$

Therefore,

$$x = y = a \;\; \text{Ans.}$$

Sometimes it is more convenient to solve for $\frac{1}{x}$ and $\frac{1}{y}$, as in the following example :

Example **4**.

$$\frac{4}{x} - \frac{3}{y} = -3. \quad . \quad . \quad . \quad . \quad (1)$$
$$\frac{2}{x} + \frac{6}{y} = 1. \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Multiply (1) by 2, and add (2), then

$$\frac{8}{x} + \frac{2}{x} = -6 + 1,$$
$$\frac{10}{x} = -5.$$

Divide by 5,

$$\frac{2}{x} = -1.$$

Therefore,

$$x = -2.$$

Again, multiply (2) by 2, and subtract (1), then

$$\frac{12}{y} + \frac{3}{y} = 2 + 3,$$
$$\frac{15}{y} = 5.$$

Divide by 5,

$$\frac{3}{y} = 1.$$

Therefore,

$$y = 3.$$

Solution is

$$\left.\begin{aligned} x &= -2 \\ y &= 3 \end{aligned}\right\} \text{ Ans.}$$

Beginners are often confused by the equations being given in the following form :

Example 5. Solve $3x + 4y - 6 = x - 2y - 8 = 5y - x + 16$.
Since
$$3x + 4y - 6 = x - 2y - 8,$$
we have
$$2x + 6y = -2. \quad . \quad . \quad . \quad . \quad (1)$$
and since
$$x - 2y - 8 = 5y - x + 16,$$
$$2x - 7y = 24. \quad . \quad . \quad . \quad . \quad (2)$$
By solving (1) and (2) we obtain $x = 5$, $y = -2$.

50. Let us now consider three simultaneous equations of the first degree containing three unknown quantities, x, y, and z. In the same way as already explained, we can eliminate one of the unknowns, say z, from two of the equations. Then, from one of these equations and the third equation, we can also eliminate z. We thus obtain two equations containing only two unknowns, x and y, and these can be solved as in the last Article.

Example 1. Solve the equations,
$$2x + 3y + z = 7. \quad . \quad . \quad . \quad . \quad (1)$$
$$3x - y - 2z = 3. \quad . \quad . \quad . \quad . \quad (2)$$
$$x + y - 3z = 6. \quad . \quad . \quad . \quad . \quad (3)$$
Multiply (1) by 2, and add (2), then
$$7x + 5y = 17. \quad . \quad . \quad . \quad . \quad (4)$$
Multiply (1) by 3, and add (3), then
$$7x + 10y = 27. \quad . \quad . \quad . \quad . \quad (5)$$
By solving (4) and (5) we obtain
$$x = 1,\ y = 2.$$
Substitute these values in (1), then
$$2 + 6 + z = 7.$$
Therefore,
$$z = 7 - 6 - 2 = -1.$$
Thus, the solution is
$$x = 1,\ y = 2,\ z = -1 \quad \underline{\textit{Ans.}}$$

Example 2. Solve the equations
$$\frac{1}{y} + \frac{1}{z} = 7. \quad . \quad . \quad . \quad . \quad (1)$$
$$\frac{1}{z} + \frac{1}{x} = 6. \quad . \quad . \quad . \quad . \quad (2)$$
$$\frac{1}{x} + \frac{1}{y} = 5. \quad . \quad . \quad . \quad . \quad (3)$$
Here, it is shorter to work as follows:
Add the three equations, then
$$2\left(\frac{1}{x} + \frac{1}{y} + \frac{1}{z}\right) = 18;$$
or,
$$\frac{1}{x} + \frac{1}{y} + \frac{1}{z} = 9. \quad . \quad . \quad . \quad . \quad (4)$$
Subtract (1) from (4), and we get
$$\frac{1}{x} = 2.$$
Therefore,
$$x = \tfrac{1}{2}.$$
Similarly, subtracting (2) and (3) in turn from (4), we get $\frac{1}{y} = 3$, and $\frac{1}{z} = 4$, so that $y = \frac{1}{3}$, $z = \frac{1}{4}$.

EXAMPLES 8

Solve the following equations.

1. $x + y = 8$, $x - y = 2$.
2. $2x + y = 2$, $x - 2y = 11$.
3. $3x - 4y = 1$, $5x + 3y = 21$
4. $2x = 9 - 3y$, $5y = 24 - 6x$.
5. $2x + 3y = 3x + 2y = 25$.
6. $\dfrac{5 + x}{3} = \dfrac{7 + y}{5} = \dfrac{9 + x + y}{7}$.
7. $\dfrac{x}{15} + \dfrac{y}{12} = \dfrac{x}{3} - \dfrac{y}{4} = 1$.
8. $\dfrac{x - y}{2} - \dfrac{3x - \frac{1}{2}y}{5} = \dfrac{1}{2}$, $\dfrac{x}{3} - \dfrac{y}{2} = 2$.
9. $\dfrac{6}{x} - \dfrac{5}{y} = 8$, $\dfrac{4}{x} + \dfrac{3}{y} = -1$.
10. $2x - \dfrac{5}{y} = 3$, $x - \dfrac{6}{y} + 2 = 0$.
11. $ax + by = bx + ay = a^2 - b^2$.
12. $bx = ay$, $ax + by = a^2 + b^2$.
13. $y + z = 7$, $z + x = 5$, $x + y = 8$.
14. $2x - y + z = -4$, $3x + y + 2z = -2$, $x + y + z = 1$.
15. $\dfrac{1}{x} + \dfrac{1}{y} - \dfrac{1}{z} = 0$, $\dfrac{1}{x} - \dfrac{1}{y} + \dfrac{1}{z} = 4$, $\dfrac{5}{x} + \dfrac{1}{y} + \dfrac{1}{z} = 20$.

Answers to Algebra

EXAMPLES 6

1. $-11a^2b$.
2. $-6xy^2z$.
3. 21.
4. x^2yz^7.
5. $-3x^4 + 4x^2 - 2x$.
6. $2x + 3y - 4z$.
7. $-3a + 2b - 12c$.
8. $x + 1$.
9. $3x - 2$.
10. $1 - 2a + 3a^2 - 4a^3$.
11. $1 + x^2 + x^4 + x^6$.
12. $x^3 - ax^2 + a^2x - a^3$
13. $a^2 + b^2 + c^2 - bc + ca + ab$.
14. $x - y$.
15. $(a-1)^2 - b(a-1) + b^2$.

Continued

BRICKWORK CONSTRUCTION

Arches. Centering for Arches and Vaults. Fireplaces. Chimney Flues and Stacks. Smoky Chimneys and Remedies

Continued from page 2268

By Professor R. ELSEY SMITH

Racking Back. It is desirable that as far as possible all the walls of a building should proceed uniformly, so that at no time may there be any great difference in level between the top of any one wall and another. This cannot always be strictly followed, and where a change of level must occur between one part and another it is best to form this by *racking back* rather than by toothing. Racking back consists in setting back each course at the end of the higher wall a quarter brick beyond the course below [**84**, page 2265]. There is less liability of a settlement occurring in this case than when toothing is employed.

Temporary openings may be formed in brick walls for the passage to and fro of materials and workmen, or for similar purposes, by toothing the sides and forming the top with oversailing courses; such openings are often protected from damage by short boards fixed against the head.

Brick Arches. Where permanent openings occur in brick walls, they are usually covered by arches also formed of brick. In external walls, for the sake of appearance, no bearer or lintol of wood or iron is, as a rule, admissible; but on the inner part of the wall where the opening is often covered by joinery or plaster, the opening is covered by a horizontal beam termed a *lintol*, either of wood or concrete, and the arch is constructed above the lintol. Such arches, which are termed *relieving* or *discharging arches*, are, as a rule, segmental in form, and the skewbacks should be formed at the extreme end of the lintol; upon them a core is constructed in brickwork and mortar shaped so as to form a permanent centre to the arch which is built up upon it [**97**]. With concrete lintols, the upper surface is usually cast segmental in form, to receive the bricks of the arch directly.

Centering for Arches. Turning Pieces. Where arches have to be constructed over voids, without lintols, a temporary provision must be made to support them until the mortar is set. In the case of an arch above the reveals of a window, which, as a rule, is only half a brick thick on the soffit, if the rise be small enough to allow of a support being cut out of a single plank or board, this is usually done; a board 3 in. thick is used and the upper side is cut to the curve of the arch to be struck, and the under side is left horizontal; it is fixed upon supports nailed to the jambs of the opening, and is termed a *turning piece* [**98**]. The arch is constructed on the back of this, which is left in position till the brickwork is set.

If the soffit of the arch exceed half a brick in width, a single turning piece will not suffice, and a centre is formed; two boards are cut to the required shape from planks 1 in. to $1\frac{1}{2}$ in. thick, placed at such a distance apart as corresponds to the width of the soffit, and secured to cross-pieces nailed below at each end; the upper surfaces have a series of wooden strips laid across and nailed to each. These strips are termed *laggings* [**99**].

For gauged work, the laggings are laid closely side by side, and the centre which is formed thus is termed *close-lagged;* for other classes of arches they are fixed at short intervals.

Built-up Centres. Where the rise of the arch is so great that the support cannot be cut out of a single board, the two sides must each be built up of two thicknesses of wood, so arranged as to break joint, and nailed or screwed together; the outer edges are cut to the curve of the required arch, and laggings are used as before [**102**].

In the case of arches of considerable rise and span, each of the side supports may require to be strongly framed and strutted in order to support the load; the form of centre will vary with that of the arch, which may be segmental [**99**], semicircular [**102**], pointed [**101**], or elliptical [**100**]; but, except in the case of arches of very long span, whch sometimes have intermediate support, they should be designed so as to throw the weight of the centre and its load on to the two ends.

For large spans, in which the centres have to support very heavy loads, it will not suffice to rely on either nails or screws for holding the sides of the centre truly in form. The centres, then, instead of being built up in thicknesses, are cut from heavier timbers and are framed together where the timbers are joined; the timbers are disposed so as to form the side into a timber truss, rigid in form, which may be supported at the two ends; curved pieces must be added to the regular timbers forming the truss where necessary to give the form required for the arch.

Supporting Centres. It is only in the case of turning pieces and centres for quite small spans that the method of support already described will suffice. For heavier work, the centres are supported by struts, the lower ends of which rest on some solid support, such as the sill of a window opening or the threshold of a door. If the soffit be wide enough to require it, two struts must be provided on each side, with a cross-piece forming the head, which should come under the cross-piece below the end of the centre. Between these, two folding wedges [**99**] are inserted, and by their means the level of the centre is adjusted. When the brickwork is considered to be quite set these wedges are loosened, and the centre is dropped slightly, so that it is no longer

in contact with the soffit; this is termed *easing the centre*, and should always take place prior to the final removal, which is termed *striking the centre*. After easing, the brickwork should be examined to see that no settlement or failure occurs before striking takes place.

Centres for Vaults. In the case of vaults, if the form is that of a plain, cylindrical, elliptical, or pointed one, it is practically treated like an arch with a very wide soffit, and in addition to the inner and outer frames, intermediate ones must be used to support the laggings.

If the vault be a groined one, formed by the intersection of two plain vaults, we shall require, in dealing with a square bay, four frames, all similar, for the four main faces; there must be in addition two diagonal frames intersecting at the centre, and marking the lines of intersection of the two vaults. If the vault be a large one intermediate frames may be introduced into each of the four compartments, to assist in supporting the laggings, which are laid on parallel to the axes of the two intersecting vaults, and meet above the diagonal frames.

Centres that have been struck may be re-used for other openings of the same size; they are, however, usually made of rough material, and are, as a rule, broken up when finished with.

Various Kinds of Brick Arches. Brick arches may be divided into (*a*) Common, or Rough arches [**97**], (*b*) Axed arches [**98**], and (*c*) Gauged arches [**99**], according to the treatment of the bricks of which they are formed. Common arches are used for all positions in rough and common work, and in better classes of work they are used for most positions in which the arch is covered by joinery or plaster.

In this form of arch the bricks are used without any cutting; it is usual to form all arches of a depth equal to at least two bricks laid on edge, and the depth is in all cases a multiple of $4\frac{1}{2}$ in. In the case of all arches, except those in which the springing and the centre are at the same level, a *skewback* [**99**] must be formed to receive each end of the arch; this is prepared by cutting the bricks carefully to the necessary inclination, which is found by drawing a line from the centre from which the curve is struck to the point in the jamb from which the arch springs, and producing it.

Building the Arch. When the centre is in position a whole brick is laid on end parallel to the skewback, and forms the commencement of the arch at each side; one such brick occurs for every half-brick in the thickness of the soffit of the arch. Between these end bricks a row of bricks on edge is laid on the core, or wood centre, starting from the two sides and meeting at the centre of the arch. The bricks must be set out so that the mortar joint is fine at the lower edge of the brick and broad at the top to make up the excess of length in the extrados beyond that of the intrados. If the width of the soffit be a half-brick, only bats will have to be used; if it be one brick thick, headers are used; and beyond this thickness headers and bats are used as required so as to bond. Such a row of bricks in an arch, equal in height to a half-brick, is termed a *ring*, and the arch is described as a *two-ring* or *three-ring* arch, and so on, corresponding with a depth of two, three, or more half-bricks. When the first ring is completed as described the second ring is formed above it, but the radiating joints between the bricks will not coincide with those of the first ring, but break joint with them, and so also with subsequent rings.

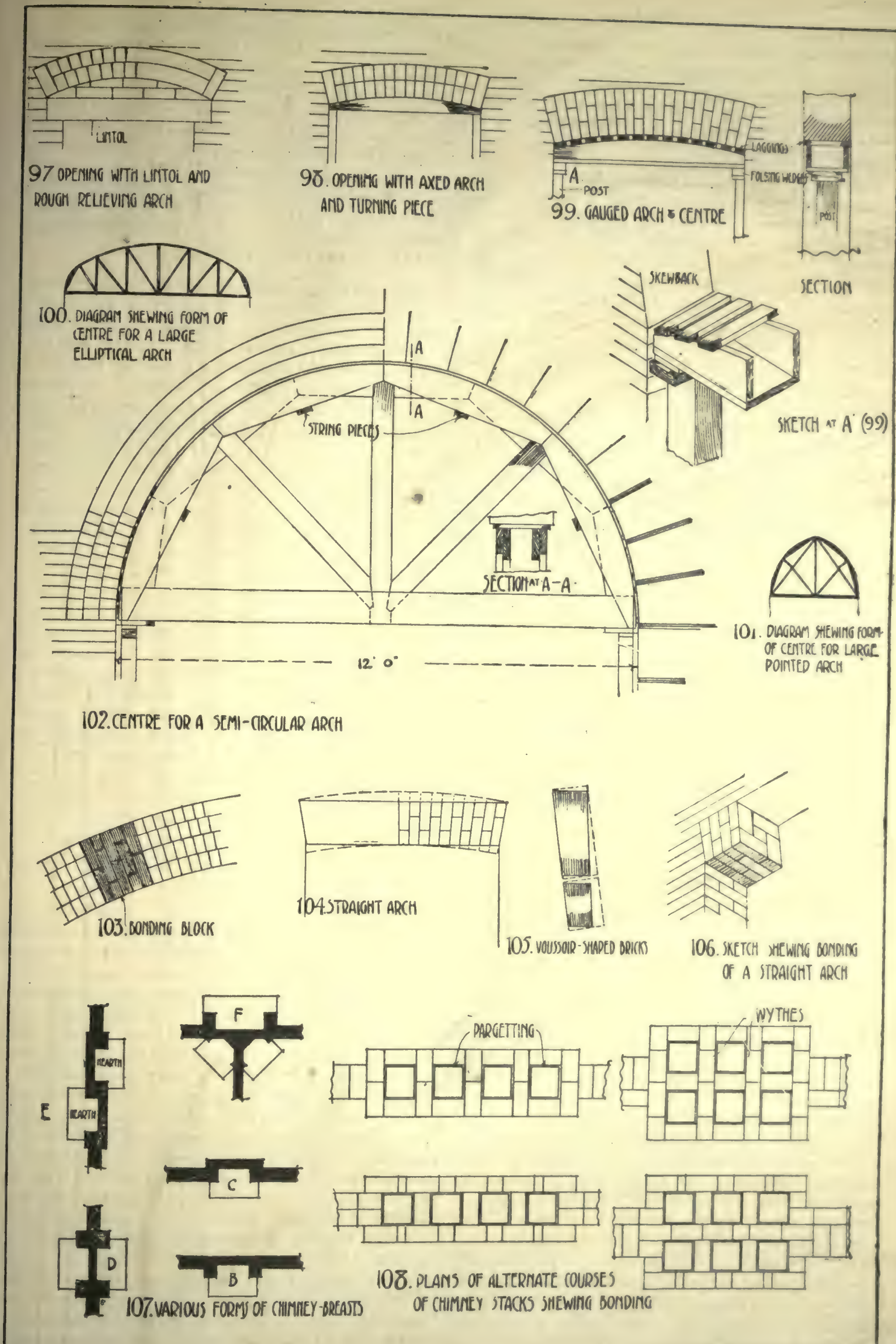
As a rule, in architectural work it is rarely necessary to employ arches exceeding three rings in depth or four at the outside, but where deep arches are required, which only occurs with a wide span, there is sometimes a tendency for the rings to settle separately and to separate from each other. To obviate this, carefully bonded blocks of brick termed *bonding blocks* extending through the full depth of the arch are introduced at intervals in such arches [**103**], or blocks of stone may be substituted. Arches are occasionally constructed of one ring of bricks only in depth, but, as a rule, for any span up to 6 ft. a two-ring arch is employed; from this width up to 16 ft. a three-ring arch, and up to 24 ft. a four-ring arch.

In the case of arches of large span it may be necessary to load temporarily the crown of the centre to prevent it from being distorted by the pressure on the sides. In the case of a brick vault, if of barrel form it is treated like an arch with a wide soffit, but if groined great care must be taken in forming the groins, the bricks for which must be axed or rubbed to the required form. The construction is facilitated by the use of groining ribs, which are in reality independent arches, and these may be first constructed on their own centres and the general surface afterwards filled in on smaller separate centres; this system is usually adopted for stone vaults.

Arches in Axed and Gauged Work. Axed and gauged arches have the bricks prepared as already detailed for these two classes of work, the latter having fine putty joints, and being used for the best class of work, but they may be described together so far as general treatment is concerned.

The essential difference between both of them and a rough arch is that instead of using parallel-sided bricks the bricks are cut or rubbed into a wedge-shaped block termed a *voussoir* [**105**], while the joints are of uniform thickness throughout; and the excess in length of the extrados over that of the intrados is thus formed in the brick and not in the mortar joint [**99**], giving a greatly improved appearance to the work, but adding to its cost. Whatever the depth of the arch, each voussoir extends through the full depth, and is, where necessary, formed of two or more bricks in height, so that a complete bond may be secured; but the width of each voussoir at the extrados cannot exceed the width of a brick, and if the arch be deep the width at the intrados is much reduced.

Any of the ordinary forms of arch described under Rough Arches as capable of construction can be better formed for facing work either as axed or rubbed arches, and, in addition, the form known as a flat arch [**104**] may be utilised. This is a true arch, being in effect a portion cut



ARCHES, CENTERING, AND FLUES

out of a larger segmental arch; the joints do not, however, radiate truly, but are formed by dividing both the extrados and intrados into such a number of equal divisions as will result in there being a central voussoir to the arch, and by drawing lines between the two series of points thus obtained.

Forming the Voussoirs. The voussoirs, if made up of two or more bricks in height, are cut or rubbed so as to give horizontal intermediate joints, and adjoining voussoirs are so jointed as to break joint [106]. It will be noticed that in cutting the bricks for a straight arch there is much waste [105], and where the depth of an arch is formed of a header and stretcher the actual depth is usually reduced to about 12 in. In semicircular, segmental, and pointed arches there need be no loss in depth; the width alone is reduced.

In forming the sides of such voussoirs it is usual to cut a groove V-shaped in section in gauged brickwork, so that when two voussoirs are placed in contact a small cavity is formed which will be filled during the process of setting by putty; this will harden, and assists to prevent the bricks from shifting laterally; this is termed a *joggled joint*.

Any such arch may have a moulding or group of mouldings run round the edge. Arches similar in form to axed arches may be formed with purpose-made bricks moulded to the required form, but if arches of various spans are struck with radii of different lengths each arch will require separate forms of bricks. It is desirable to use specially-made bricks for all articles executed in glazed brick, as the glazed surface is apt to be chipped in the process of cutting.

Fireplaces. In forming fireplaces it usually happens in modern houses that the walls are not thick enough to allow of the necessary recess being made in them, and where a fireplace is required, the wall has to be thickened. This may be done if the wall is external on the outside [107 C] by projecting the back beyond the outer face of the wall, or on the inside by projecting the front, termed the *chimney-breast*, into the room [107 B]; but in all cases where a wall is thickened for this purpose the footings need not be increased in depth but may have the same number of courses as in the adjoining wall.

In the case of a party wall, the projection must be into the room, and the back of the recess must be at least 4 in. from the centre of the party wall [107 D]. In the case of an internal wall the projection is usually into the room, and if two fireplaces occur back to back the projection is considerable; if they can be arranged side by side the projection may be reduced, but in such cases the fireplace will not come centrally in the breast [107 E].

In some cases it is convenient to form a fireplace across an angle of a room and two or more may occur in adjoining rooms so as to form a stack [107 F]. On an upper floor a chimney breast may be corbelled out from a wall, but the extent to which it projects should not exceed the thickness of the wall carrying it [88, page 2265].

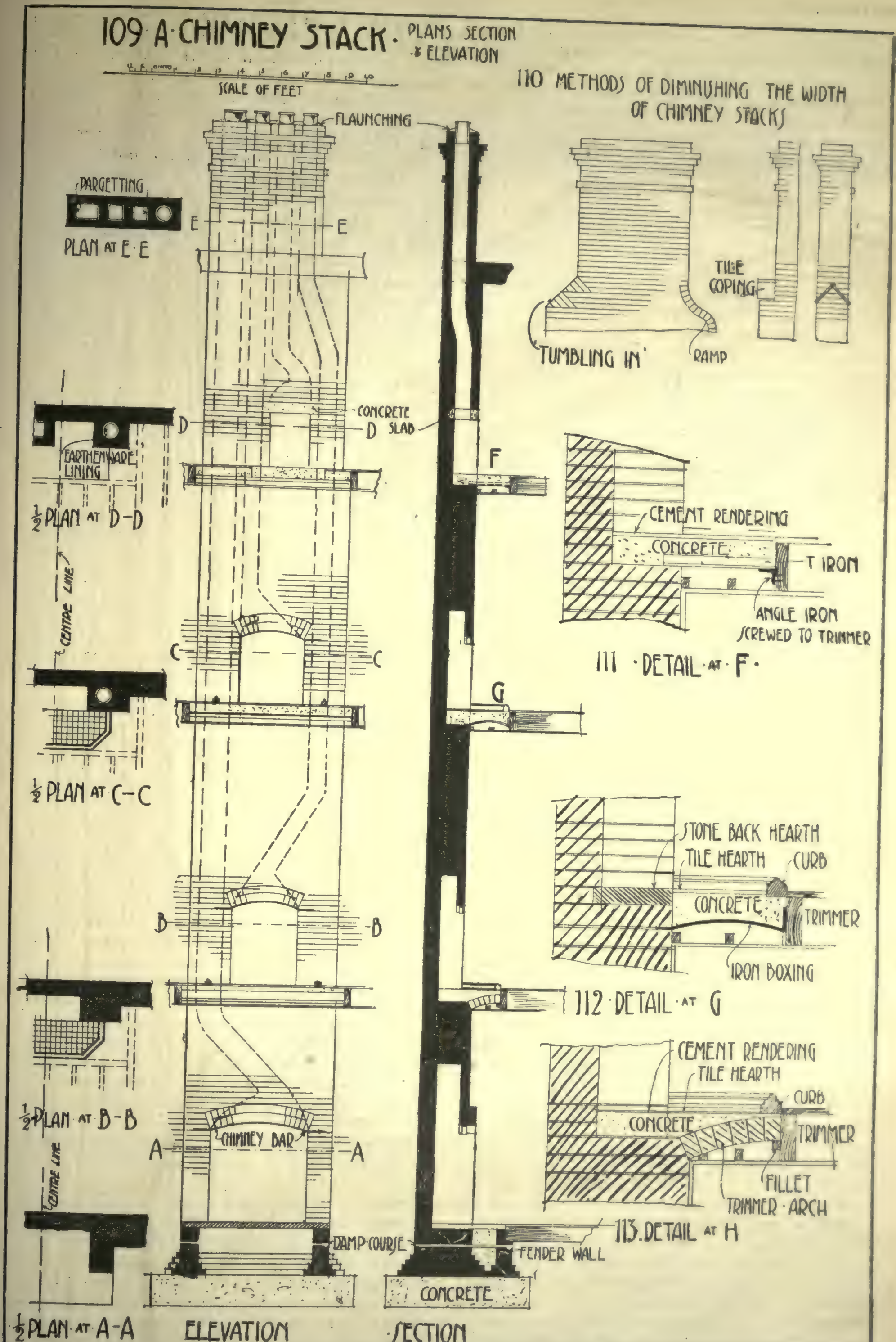
Forming the Hearth. The opening itself commences at least 3 in. below the floor level to give depth for a hearth of stone, cement, tiles, or other incombustible material, and the floor in front of the breast is *trimmed* if formed of timber [see CARPENTRY]—except on the lowest floor, where a fender wall may be formed. The space thus formed, which must extend 1 ft. 6 in. at least in front of the breast and 6 in. on each side of the opening, is occupied by a trimmer arch [113], or by a concrete bed supported on angle-irons spiked to the wood joints [111] or on an iron boxing [112].

The Fireplace Opening. The width and height of the opening vary with the kind of grate to be inserted. The top of the opening is rarely lower than 3 ft. from the floor, and may be considerably higher; the width should be at least 1 ft. 6 in. for the smallest bed-room grate, and about 3 ft. is usual, and even more is required, for many grates and ranges.

It is well to make the openings amply large; they may easily be filled in with brickwork afterwards, but it is troublesome to enlarge them. The opening is finished at the top by a rough brick arch, which is usually formed on a wrought-iron cambered bar, termed a *chimney bar*, about $2\frac{1}{2}$ in. wide and $\frac{3}{8}$ in. to $\frac{1}{2}$ in. thick. The ends of this should be 9 in. long, and are split, one half bent up, the other down, to build into brick joints. Behind this arch, which carries the front of the breast and is usually only one-half brick in thickness, the sides are gathered over until the width is reduced to that of the flue which is to be carried up [109]. The flue may rise from the centre or from either side, and sometimes a ledge is formed to check down-draught [109 C–C]. In gathering over, the lower edges of the bricks are rough cut, so as to give an evenly-inclined surface. A block of concrete, perforated for the flue opening, may be substituted for the arch and gathering over [109 D–D].

Chimney Flues. Flues are usually 9 in. square or 9 in. by 14 in.—rarely larger for ordinary domestic work, but for the furnaces of hot-water apparatus and large cooking stoves larger flues may be required. They are surrounded throughout and separated from each other by brickwork at least one-half brick thick, and the separating or enclosing wall thus formed is termed a *wythe* [108]; every fireplace has a separate flue carried up to above the roof level. Where several flues occur close together, as when two or more fireplaces occur on a floor in close proximity, or a series of fireplaces are formed on successive floors, one above the other, they are combined into a block termed a *chimney stack* [109]; a special method of bonding is made use of, known as *chimney bond*, mainly composed of headers [108].

In forming flues, which may be carried up vertically, inclined at any angle, and even twisted on their axis if occasion require, great care is necessary to see that the proper sectional area is nowhere reduced; if this occur the flue is said to be *crippled*.



DETAILS OF CHIMNEY CONSTRUCTION

Any flue inclined at an angle flatter than 45 degrees requires to be provided with openings fitted with soot doors to facilitate sweeping. These *soot doors* consist of a small iron door and frame which is built into the side of the flue and which, when closed, is perfectly air-tight, but which can be opened for sweeping.

Parging and Coring. As the flue is formed it is carefully plastered on the inside — the process is termed *parging* or *pargeting* [**108**]; its object is to fill up all joints in the brickwork and to present a smooth, even internal surface to facilitate cleansing. The mortar used for parging usually has cow-dung mixed with it, in the proportion of three parts of dung to one part of lime, which forms a tough material less liable to crack than ordinary plaster. The construction of the flue requires careful watching to see that after parging no mortar droppings are allowed to fall on the finished surface, or, if they fall, are at once removed. The best plan is to block the opening below the level at which work is carried on by a bundle of shavings, On completion the flues are *cored* by passing a stiff wire brush down to clear away mortar droppings. Sometimes a solid wooden ball 8 in. in diameter is passed down every flue to ensure that no crippling has taken place. The top of the flue is often finished with a circular terra-cotta pot; this may be plain and stand only a few inches above the brickwork, its object being to protect the bricks round the top from damage when the chimney is swept; and in some cases flues are lined throughout with similar tubes, and do not then require parging. In other cases ornamental chimney-pots are employed, which may stand nearly their full height above the brickwork. The flat top of the brickwork is finished with a weathered cement surface, here termed *flaunching* [**109**], completely covering the top of the brickwork and finishing against the pot. Various special forms of pot have been designed to counteract down-draught in the flues, and consequent smoking fireplaces, some of which are of earthenware, but they include tall—sometimes bent—pipes of zinc known as *tall-boys*, formed with a flange at the bottom which rests on the brickwork, and is secured to it; some of these terminate with a rotating cowl.

Smoky Chimneys. It is often difficult to cure a smoky chimney if its condition is due to faulty construction or design, and the following points should be carefully attended to.

The flue must on no account be crippled. No connection with any second fireplace or stove should be made. The flue of a domestic fireplace should not be perfectly vertical throughout its height, but at some point it should be carried over to one side or the other to such an extent at least, that it is impossible to see sky through the flue from the fire opening. The top of the flue should not be finished below the level of the ridge of a high roof, or the wind, when in certain quarters, may sweep over the ridge down upon the chimney and create down-draught. A smoky chimney is not infrequently due to an inadequate supply of air to some other fireplace in which a good fire is burning, which, if unable to draw sufficient quantity of air from other sources, creates a down draught in the neighbouring flue; this may often be remedied by taking an air shaft from the outer air to the neighbourhood of the hearth.

The Use of Dampers. In forming flues from all kinds of furnaces, including coppers, and from kitchen ranges, a *damper* is usually built in; this consists of a sheet of iron the full width of the flue, which usually slides in an iron groove built into it, and when closed entirely blocks the flue; it can, however, be drawn out so as to leave it quite open or be fixed at any intermediate point, thus regulating the draught in the flue, the rate at which the fire burns, and the particular part of the range it is desired, at the time, to heat—*e.g.*, the oven, boiler, etc.

Setting Stoves. The actual stove or grate in which the fire is lighted must be built into the rough opening already described. Such stoves vary much in form; some are entirely formed of fireclay or brick, and most have a fireclay back and sides. They are placed in the recess, and should be set in brickwork, care being taken to fill up the back as well as the front, so that no cavity is left in which soot may accumulate, except in those cases in which a special warm air chamber is formed behind the stove, for introducing warm air into the room. Particular care must be taken to close the space between the front of the stove and the opening, as if this be not properly done smoke is liable to issue from it around the ornamental front or chimney-piece.

Setting Ranges. Ranges vary greatly in form and size. Some are termed self-setting, and merely require to be stood in a prepared opening with the flue pipe taken up into the chimney, the bottom of which may be closed. With many ranges the work is more complicated; they usually include a fire-box, which may be open or closed, and one or more ovens and a side or back boiler. In setting them it is necessary to construct the flue or flues from the fire-box to the chimney, so that the heat from the fire may be directed as desired, either mainly to heat the water in the boiler or to heat one of the ovens; each of these flues must, therefore, be controlled by a damper. This work is best executed in firebrick set in fireclay, but this is not absolutely necessary for small ranges; in all cases it is important that the instructions for forming the flues, which are supplied by the makers of many special forms of range, should have careful attention.

Furnace Flues. All flues from heating apparatus cooking stoves and ranges, except ranges in private houses, and similar flues in which a somewhat fierce and continuous heat is usual, should be surrounded by at least 9 in. of brickwork, and should be formed with firebrick if the heat is great. In most districts the conditions governing the construction of fireplaces, flues, ovens, factory chimneys, and similar works are dealt with by the local building regulations, which should be consulted.

Continued

THE ATOM'S WONDERFUL SECRET

Continued from page 2298

The Death-bed of the Atom. The Wonderful Power it Gives off in Dying. Can We Use It? Will the Immeasurable Energies of the Atom Transform Society?

By Dr. C. W. SALEEBY

THE reader is besought not to imagine that the overwhelming and all-embracing significance of the corpuscular theory of matter has been completely indicated; but we may fairly take stock of our theory at this point, and notice how it accords with the statements which we made in leading up to and introducing it. We insisted upon the ultimate inseparableness of physics and chemistry, while pointing out that the physicist is mainly concerned with energy, and the chemist with energy only or mainly in the form which he calls chemical energy. We observed that the difficulties of chemistry are approaching solution at the hands of what is called physical chemistry, and we insisted upon that doctrine of the conservation of energy which, if it is really true, must necessarily be true in every chemical action.

What Have We Found? In the first place we have found that physics and chemistry are so much one that it is now almost ridiculous to speak of chemical energy. Chemical energy is electrical energy. In the second place we have found that the magnificent work of two chemists, Dalton and Mendeleef, has been crowned, and the greater part of the problems of chemistry have been solved, by the labours of a worker who is not a chemist at all, but a physicist. As for the law of the conservation of energy, we cannot yet point out its relations to the theory of Thomson, but we need only remind ourselves of what was lately said about negative electrons shot out from the atom of radium in order to see that the law of the conservation of matter requires revision. Now this law must apparently be regarded as a particular expression of the law of the conservation of energy. And if it be not true, what are we to say of the law which includes it and of which it constitutes a part? And how can we possibly assert it to be true in the same breath as that which serves us to say that negative electrons are shot out from unstable atoms such as that of radium, and go—whither? Do they disappear, are they annihilated, are they resolved into ether, the "mother of matter," or are they conserved as such?

Unstable Atoms. We are already in a position to understand that, in speaking of atoms, the terms *stable* and *unstable* are relative. The perfectly stable atom would, of course, be eternal; whereas the perfectly unstable atom would have no period of existence as an atom at all. Remembering this, however, we have to recognise that different types of atoms do vary enormously in their degree of stability, and it is obviously incumbent upon the new theory of matter to explain these differences if it can. It is impossible to discuss this subject, at the present time, in any complete way. The two most distinguished of the workers whose names have so often been mentioned since we began the discussion of the new chemistry, are now preparing books upon the subject, one dealing with the Transformation of the Elements and the other with the Corpuscular Theory of Matter. But these books cannot yet appear, because it is as yet impossible to reach the point at which even temporary finality is obtained. Since the greater part of the world of physicists and chemists are working at this subject new and important facts are being discovered about as rapidly as the old ones are being set down in print. Nevertheless, some provisional statement is already possible.

Atoms Within Atoms. Our previous discussion of the corpuscular theory of matter has enabled us to understand as ten years ago not the greatest of living chemists could have understood a large number of the great facts of chemistry. What amplification does it need in order to enable us to understand the extraordinary fact, discovered by Sir William Ramsay, that small atoms may be born from large ones?

One most important fact has been demonstrated by Professor Thomson. He shows that it is possible to substitute a system of corpuscles for one corpuscle in certain of the theoretical figures we have described. Thus, three corpuscles arranged in the triangular fashion already figured may exist within an atom and act as a whole just as one corpuscle would act.

Evidently, this is most important, for it at once gives us some inkling of the manner in which such a small atom as that of helium may spring, practically ready-made, from an atom of radium.

Movement of Electrons. Professor Thomson has also shown that important facts may be deduced from the movement of the electrons. In a paragraph in a previous section we commented briefly on the movement of the electrons in the atom and showed that the difficulties which it appears to introduce are not serious; but now we may amplify the statement and say that the movement of the electrons actually helps us in our attempt to explain the existence of unstable atoms. Let us take, for instance, the case of five Mayer magnets. It is found that there are two ways in which these may arrange themselves, sometimes as a pentagon and sometimes as a square with one corpuscle in the middle. Now, Professor Thomson has shown how the possibility of these two arrangements may be explained in the case of the very simple atom which we are imagining for purposes of study. When the

electrons in such an atom are moving very rapidly, the arrangement will be that of the square with one corpuscle in the centre; but if their energy of movement is reduced, another arrangement becomes necessary, *and suddenly so*. There must be a certain *critical point*, above which one arrangement is necessary, whilst below it another is necessary.

The Death-bed of an Atom. If we conceive of an atom, parts of which are in movement, we have to ask whether any energy is being lost; there is a most extraordinary and significant parallel between this question and the questions as to the stability of the Solar System or of Saturn and his rings. We may note, by the way, that a Japanese physicist has made an interesting contribution to the theory of the radio-active atom by means of considerations derived from the study of the rings of Saturn.

Now, we have to believe that every atom is slowly losing its energy, this being the fundamental reason why it is *mortal*. In a lecture delivered a few days before these words were written, Professor J. J. Thomson spoke of the "death-bed of atoms," and pointed out that it is at the moment of death, so to speak, that the radium atom gives off the energy for which it is so famous. For ages it has slowly been losing its energy, and at last the point comes which we have called critical. An entirely new arrangement is necessary if the atom is to persist in any shape or form, and this involves the great reduction of the potential energy within the atom and the giving forth of a quantity of kinetic energy proportionate to that reduction. "The only tax the radium atom has to pay," says Professor Thomson, "is the death duty." The amount of kinetic energy which is evolved at the death-bed of the radium atom—after its long life, according to the latest estimates, of 1,200 years—is so great as to suffice abundantly for shooting out from the atom a certain number of its parts. We have only to suppose that among its parts are little systems of corpuscles, which are nowadays going by the name of *sub-atoms*, and which, if they could get free, are none other than atoms of helium.

A Key to a Mystery. We have already seen that the existence of such systems is quite possible, each of them being equivalent, in the structure of the atom, to one corpuscle, and acting as such. The so-called Alpha rays of radium consist, it is believed, of such sub-atoms, which are really equivalent to atoms of helium. These do not, indeed, consist of three corpuscles, as in the case of the sub-atomic system of the imaginary atom we have discussed, but probably of about 2,000 corpuscles (compare the atomic weight of helium and that of hydrogen).

Such an explanation as we have given is of the greatest value, in that it serves to explain what otherwise seems unintelligible. Why, we might ask, should an atom actually persist for twelve hundred years unchanged and then suddenly break down of its own accord? But now we have a key to this. We see that atoms do not persist unchanged; during all this period the atom, indeed, retains its form and structure, but it is slowly radiating energy. At last there comes the critical point at which the old arrangement is no longer stable—and then comes the crash. The reader will readily be able to supply analogies from his own experience. Why, it might be asked, should a man live at ease and in luxury for years, and then, all of a sudden, be thrown out of the society in which he lives and become a bankrupt and a pauper? The answer is, that though his circumstances have apparently not been changing, he has been living on his capital, radiating his potential energy, and at last a critical point is reached—and then comes the crash.

And now we are the better able to understand what we described on page 1916 as the "emanation" of radium. We saw that this element yields a gas, or emanation, which is not gaseous radium. We saw also that Sir William Ramsay has discovered that when the spectrum of this emanation is examined after an interval of four weeks or less the spectrum of helium is recognised. But lately we have passed beyond the simple view that the emanation of radium consists of a multitude of immature and unrecognisable helium atoms. That was hardly credible at any time. What, then, can we provisionally regard as the exact relation between the helium produced by radium and the emanation which it also produces?

The Emanation of Radium. It seems that the emanation itself consists of atoms which are of very large size indeed; not as large as the radium atom, however, though they belong to the same type. For the time being we may, perhaps, conceive—possibly in more simple terms than may ultimately be shown to be justified—that when the radium atom reaches its critical point, it breaks up into one or a number of alpha particles or helium atoms on the one hand, and one of these large emanation atoms on the other. These repeat, though with very great speed, the history of the original atom. Before long they break up, yielding more alpha particles or helium atoms, and a second type of emanation, which has been called emanation X. This again breaks down in its turn after a short time. There are in all probably five stages, as we have already seen, and we have already noted that the final atom—or, rather, the atom which is final for a time—seems to be that of lead. As for the first emanation, and the assertion that it consists of definite atoms of an absolutely distinctive and specific kind, we may note that Sir William Ramsay proposes to call it *ex-radio*—to indicate that this is an *element derived from radium*.

We have spoken of these various stages, but the reader must not imagine that there is any equivalence of time between them. The radium emanation undergoes its change in a matter of days. Emanation X takes only a few minutes; the next two stages not many minutes more; but the last stage, of which lead, perhaps, is the final product, is estimated to take centuries.

The Internal Energy of Radium. And now we are also in a position to add somewhat to our previous remarks concerning the energy of radium. We accept, of course, the disintegration theory, having been able to exclude the previous theories advanced by Sir William Crookes and by Lord Kelvin. The reader will scarcely need us to insist that when we discuss radium we are discussing principles which are true of atoms generally. On page 2029 it was said that "the eternal energies of radium can be manifested only at the cost of its internal energies . . . . it is only in virtue of the disintegration of its atoms that radium has been able to exercise its remarkable properties." There is not much need to insist again upon the enormous measure of the energy which is liberated by the disintegration of such a large atom as that of radium. Professor Thomson has quite recently made an important criticism upon the often-repeated statement that, say, half a pound of radium would drive a steamer across the Atlantic.

So it would, if it were possible to obtain half a pound of radium in one mass; but it would take an extremely long time to do so, and for this reason: we have to conceive of the energy given out by radium as due to the breaking up of its atoms, *one after another*, as their internal arrangements reach the critical point. It is only on its death-bed, to vary the metaphor, that the radium atom parts with its fortune or power to any appreciable degree. The heat evolved by radium—or, rather, by the breaking up of such atoms in a mass of radium as may happen to break up during the period under observation—is believed to be mainly due to the alpha particles. The heat is evolved partly by the impact of these particles upon the rest of the radium, and partly by their impact upon surrounding objects. These alpha particles are thrown out from the emanation in all its successive stages. It has been calculated that about three-fourths of the heat produced by radium is thus due to its emanation, in virtue of the alpha particles produced.

The Power of a Thimbleful of Radium. We may quote from Professor R. K. Duncan, who has admirably arranged many of these remarkable and recently-discovered facts in his recent volume, "The New Knowledge." Professor Duncan says, on this point: "The volume of the emanation is infinitesimally small. From one gramme of radium compound the volume of the emanation evolved would not account to more than 1·3 of a cubic millimetre. This needle point of gas evolves enough heat per hour to raise the temperature of 75 grammes of water one degree. If it were possible to obtain one cubic centimetre—a thimbleful—of this emanation in the form of a gas, we should find that it possessed the power of emitting, altogether, over 7,000,000 calories of heat. This is more than sufficient to raise 15,000 pounds of water one degree, and all this heat from a thimbleful of an invisible gas! The important phase of this statement is that it is altogether outside of any hypothesis or theory. It is a simple, straightforward fact. Now, the heat evolved by exploding the same volume of hydrogen and oxygen mixed in the proportions required to form water is about two calories. We find, then, that the heat evolved by the radium emanation is over 3,500,000 times greater than that let loose by any known chemical reaction."

An Amazing Waste of Power. So much for the amazing measure of the energy which is involved in the structure of atoms. We may turn also to the smallest atom we know—that of hydrogen—the atom which contains much less energy than any other, and quote the estimate of Professor Thomson that "a gramme of hydrogen has within it energy sufficient to lift 1,000,000 tons through a height considerably exceeding 100 yards." In short, of all the energies which we know in Nature, those which we have long recognised, those extra- or inter-atomic energies which are constantly utilised in order to do the work of the world, are as nothing, are utterly insignificant and negligible compared with the *intra-atomic energy*—the energy which is within the atoms of matter, of which hitherto no use whatever has been made by man.

But before we pass on to consider, at some little length, the nature of the units of which atoms are composed, we may note briefly another consideration. As we all know, time was when society was based upon militarism, whereas to-day it is tending to become industrial. The military type of society is the oldest and, of course, the lowest. We have not yet reached the stage when society has become perfectly free from militarism; but every one who thinks about man and his future looks forward to the day when society will have become completely industrialised and when war will have ceased for ever.

The Transformation of Society. But there are a few thinkers here and there who are inclined to question the common view that the industrial state of society is the best that can be conceived. At present, as for many ages past, we are engaged in an incessant strife with Nature, and the balance of power is at last coming to lie with "man's unconquerable mind." This is so because we are learning how to utilise natural powers. Nevertheless, an enormous proportion of all mankind are engaged, at one level or another, as "hewers of wood and drawers of water." This is as good as to say that our conquest of Nature is yet far from complete. But, if we are to judge by the past, we may believe that, in time to come, society will be no longer industrial, for the reason that industry, as we at present conceive it, will not be necessary. The fact of what are called "labour-saving devices" is one of the most important facts in the whole study of man. Even if we utilised to the full all the ordinary chemical energy which we employ in our furnaces, for instance, there would be a vast economy of labour. The time will unquestionably come when the work of the world, in nearly its whole extent, will be done, not by half-clad men

digging coals out of mines or puddling iron, but by the simple pressing of a button. Society will have to pass through stages comparable to those represented by the introduction of the various mechanical inventions which have replaced, let us say, the old spinning loom.

The Immeasurable Energies of the Atom. It will seem, and unless we are more humane in the future than in the past it will indeed be, cruel to throw countless persons out of work by the introduction of new methods. But what are we to say if we remember the existence of the immeasurable and inexhaustible energies which lie within the atom—the atom which our very fathers thought to be dead and inert? In a small book published some time ago, the writer ventured to call the future social type the *spiritual*, as distinguished from the *militant* and the *industrial*. In so far as any forces other than spiritual forces can hasten the coming of this social type of the future, such forces are undoubtedly to be sought chiefly in the almost unimaginable transformation of all the material conditions of human life which will be achieved—which may, indeed, be made possible at any moment—by the discovery of some means of "tapping" the intra-atomic energies. Were this done there would be practically no longer any necessity for any of those labours of man which depend upon his need for turning to his own advantage the forces of nature. Let the reader ask what proportion of human work ultimately comes under this head, and then let him consider how human life must be transformed if such work be rendered unnecessary.

The Power of Every Breath We Draw. We have already referred to some of the uses of radium, but all that we have said is simply as nothing compared with the uses to which radium, and, indeed, all atoms whatsoever, may be put if we are able to harness them. As Professor Duncan picturesquely phrases it, "What man earnestly longs for he will obtain. If he knows that every breath of air he draws has, contained within itself, power enough to drive the workshops of the world, he will find out, somehow, some way of tapping that energy." There is nothing inherently impossible in the attempt. It is not a case of making a perpetual motion machine, nor of getting work under conditions which, according to the second law of thermodynamics [see PHYSICS], are incapable of yielding work. A very recent speculator suggests, and he is probably right, that the processes of intra-atomic change, unlike the processes of inter-atomic combination and dissociation, are irreversible. It would almost appear as if there were a precise parallelism between the laws of *heat and work* and the laws of *intra-atomic energy and work*. If this be so, we shall never be able to build up a radium atom from smaller atoms, except by somehow putting back into these smaller atoms all the tremendous energies which were dissipated when they were born. Instead of having work done by this process we should have to do an enormous amount of work in order to accomplish it.

But, on the other hand, there is no reason at all why we should not utilise the energies evolved in the breaking down of large atoms into small ones. The problem, indeed, is not so much how to utilise the intra-atomic energies as how to hasten their normal evolution. Our half-pound of radium would drive the liner across the Atlantic, but it might take ages and ages to do so, simply because a sufficient number of the radium atoms would not liberate their stored-up energies within a reasonable time. The question, then, is how to hasten the normal rate at which atoms disintegrate. In many parts of the world inquirers are now attacking this problem.

"Blowing Atoms to Bits." Not so long ago, for instance, when the present writer paid a visit to the laboratory which may perhaps be best indicated by describing it as the foremost physical laboratory in the world, he witnessed certain experiments with the Röntgen rays, the object of which was to "blow atoms to bits," if possible, and utilise the energies liberated by the explosion. That is a metaphorical manner of speech, but it is extraordinarily near the literal truth. We may fairly say that in practical physics at the present moment—or in practical chemistry (it does not matter which one says)—the most interesting and important inquiry is *how to blow atoms to bits*, thereby obtaining from them far more energy than one puts into them, just as a little match may make the beginnings of a very big blaze. After all, it is the old problem of transforming potential into kinetic energy, in a new dress. In setting a light to gunpowder so as to send off a cannon-ball, we are transforming into kinetic energy the potential energy contained and locked up *between* the atoms and *in* the molecules of the gunpowder and the oxygen of the atmosphere. Similarly, in attempting to blow atoms to bits by Röntgen rays or other means, we are seeking to transform into kinetic, or utilisable, energy, the potential energy which, as we have already seen, is contained, and contained to an almost incredible degree, *within* the atoms.

Professor Thomson's Latest Views. If the reader be wise he will welcome the quotation of Professor Thomson's own words, as nearly as possible, from the very last pronouncement he has made (March 24, 1906, at the Royal Institution), when these words are written. We quote or paraphrase the following:

In one hour one gramme of radium will give out sufficient heat to raise a gramme of water from freezing point to boiling point. On the average, a radium atom lives for more than 1,000 years, and it is only at the expiration of this period, when the atom becomes unstable, that its energy is liberated. This is a long period, even by our scale of reckoning, in which we take the rotation of the earth as the unit of time. If an atom of radium had an inhabitant, he would reckon on quite a different scale of time. Doubtless his unit would be the period of rotation of one of the corpuscles or systems of corpuscles in the atom, and it would correspond to a small fraction of the billionth—that is, the million millionth—part of a second. The life of a radium atom—

say, 1,200 years—might well appear, therefore, as an eternity to one of its inhabitants, thus raising the question "how is it that the radium atom, after existing for what—relatively to the rhythm of its own processes—is practically an infinity of time, at last collapses and suffers this extraordinary change which results in the giving off of energy?" This change is due to the loss of energy in the corpuscles and systems of corpuscles which rotate in the atom. The atom thus loses its state of moving equilibrium, as a top falls when the speed of its rotation is insufficient to preserve *its* moving equilibrium.

Can We Harness the Atom? Thus the energy of radium is displayed only at the deathbed of the radium atom. During its lifetime radium is a perfectly conventional element, so far as we know; it is only when it is ceasing to be radium that it begins to display its peculiar properties and gives off energy. So great is the amount of this energy that there is enough of it in a pinch of radium to carry an Atlantic liner across the Atlantic at full speed. Nevertheless, by no means at present known could a pinch of radium be made to do this, since, though it contains all this amount of energy, it gives it off with extreme slowness. In order to propel an Atlantic liner across the Atlantic in six days, 100 tons of radium would be required. The question is whether we shall be able to get at the internal energy of the atom *at a fast enough rate to be of practical value.* It should be well recognised that at present this is impossible—knowledge which will prevent the public from supporting bogus companies, the promotion of which is unfortunately one of the most frequent applications of science. A company has lately been started, or projected, which is to disintegrate the atoms of ordinary substances, with the consequent evolution of so much energy that coal will soon cease to be of any value!

And now, having considered the nature and possibilities of the atom as best we might, and having been put off again and again in our attempt to answer the root question of chemistry, which is the question of the nature of matter, we must turn to the study of those very units of which atoms are composed.

The Ultimate Units of Matter. We are now quite familiar with the Beta rays of radium and other bodies, and we are able to assert that they constitute the ultimate units. The Gamma rays we may ignore, since we believe them to consist merely of an ethereal wave motion like light and the Röntgen rays [see PHYSICS]; nor need we concern ourselves with the Alpha "rays," since we are now learning to call them alpha *particles*, and believe that they are really atomic and made up of the same constituents as the Beta rays themselves; nor does the recent discovery of the Delta rays of radium complicate the matter. We may concentrate ourselves entirely upon the constituents of the Beta rays. These are the ultimate units of matter. What we have already asserted about them may be easily summarised. They are probably identical in all their properties wherever found. Each either *carries* or *is* a charge of negative electricity. If the latter be true, then the ultimate units of the atoms of matter are atoms of electricity.

M. Poincaré's Remarkable Work. It is precisely this point that is now being determined. For a provisional answer to it we can scarcely do better than turn to certain French students, remembering that the history of science has taught us how lucid and brilliant are French men of science in these matters. M. Poincaré is known at this moment as the most distinguished combination of man of science and philosopher. His remarkable book, "Science and Hypothesis," was translated into English last year, and the reader who proposes to plumb to their depths the problems to which he has been introduced in this and its companion course will do well to acquaint himself with M. Poincaré's thinking. On page 165 (English translation—the Walter Scott Publishing Co., Ltd.), M. Poincaré says: "It is true that in the electrons the electricity is supported by a little—a very little—matter; in other words, they have mass." That is all that can be obtained on this particular point from this remarkable volume, but physicists have advanced since those words were written. Is it really the fact that the electricity of the electrons is supported by even a very little matter? It is certainly the fact that these electrons or corpuscles have mass, and, writing two or three years ago, M. Poincaré assumed, as everyone did assume, that wherever there was mass there was matter.

"The End of Matter." The question now, however, has taken a new form. Is it necessary to assume the existence of anything but electricity in order to explain the known mass or inertia of the electron or negatively electrified corpuscle? Are its mass and inertia anything more than electrical mass and electrical inertia? Perhaps, before we go further into the properties of the electron, we may state how this question appears at the present moment. M. Poincaré himself contributed an article upon it, in his brilliant French, to a recent number of "The Athenæum." He called that article by the sensational title, "La Fin de la Matière" (The End of Matter). It consisted of a masterly summary of the most recent work, the probable conclusion of which is that when sufficient of the mass and inertia of the electron have been allotted to satisfy the demands of electricity, there remains none whatever to be allotted to matter. Hence, M. Poincaré ventures to speak of the "end of matter." The root question of chemistry is the nature of matter, which has been regarded as an ultimate since men began to think, and the nature of which has been a subject of speculation for nearly three thousand years; and the answer of contemporary science is that matter is not an ultimate at all, but is a form of electrical phenomenon.

The author of a volume which has now become famous—"L'Evolution de la Matière"—has coined the phrase, "the dematerialisation of matter." Both this book and M. Poincaré's

"La Science et l'Hypothèse," are published in the "Bibliothèque de Philosophie Scientifique." Both have lately been translated, but are much preferable in the original for the reader of French. As Mr. Balfour lately put it, "matter has been not merely explained, but explained away." We must inquire into this.

The Fate of the Electron. A few pages back we raised the question, *apropos* of the doctrine of the conservation of matter, as to the fate of electrons. It was pointed out that we can no longer assert the doctrine of the conservation of matter to be true "in the same breath as that which serves us to say that negative electrons are shot out from unstable atoms such as that of radium, and go—whither ? Do they disappear ? Are they annihilated ? Are they dissolved into ether, the 'Mother of Matter,' or are they conserved as such ?" Now what help does M. Gustave Le Bon afford ? If he cannot help us, we must wait for further information until Professor Thomson sums up the results of his recent researches. The reader will not expect us to be dogmatic. If he wants positive, dogmatic, unqualified statements, he must turn elsewhere—perhaps to the theologians, perhaps to the materialists, of thirty years ago. Contemporary physics is unfortunately unable to do anything more than lay certain facts before the student and suggest the possible interpretations of them. In the following paragraphs we shall freely paraphrase from M. Le Bon (French Edition, 1905, page 292, etc.).

It looks as if the last term in the dematerialisation of matter were the ether, into the bosom of which, so to speak, the negative electron shot out from a decomposing atom is plunged. What is the fate of the atom of electricity—the electron or negatively electrified corpuscle—after the dissociation of matter ? Does it remain eternal, when matter no longer exists ? If it retains its identity, for how long does it do so ? And if not, what becomes of it ? It is scarcely conceivable and is certainly quite improbable that these electrons retain their identity. They must lose their individual existence and disappear. If it be asked how, we may gain some understanding of it by considering the case of icebergs floating in the Polar oceans and retaining their individual identity until, at last, the temperature becomes warmer and they vanish and disappear in the ocean. "Such is, without doubt," says M. Le Bon, "the ultimate fate of the electric atom (the electron). When it has radiated all its energy it vanishes in the ether and is no more."

The Last Stage of Matter. Furthermore, M. Le Bon points out that in the course of the movements of electrons and their loss of energy various forms of vibrations of the ether are observed, such as the Hertzian waves, radiant heat, visible light, invisible ultra-violet light (to which we may add the Röntgen rays). The nature of all these is the same. "They are comparable to the waves of the ocean, which differ in size alone. These ethereal vibrations, always accompanying the electric atoms (electrons) very probably represent the form under which they vanish in radiating their energy." "Thus," says M. Le Bon, "the electron, having its own individuality and a definite and constant mass, must constitute the last stage but one in the disappearance of matter. The last will be represented by the vibrations of the ether—vibrations possessing no more permanent individuality than the waves which are formed in water when one throws in a stone and which soon vanish."

The last question, or almost the last, is this : How, exactly, can we conceive of the transformation of the electron into ethereal vibrations ? There are a thousand considerations which conduce to the belief that these ultimate particles may be compared to whirlpools—the vortex atom theory of Lord Kelvin may well remain, though transferred from the atom to the electron. "The question, then, reduces itself to this: How can an eddy, or vortex, formed in a fluid, disappear in this fluid while producing waves in it ? Thus stated, the problem is intelligible. In fact, one sees easily enough how an eddy formed in a liquid is able, when its equilibrium is troubled, to vanish while radiating the energy which it contains under the form of waves in the medium which surrounds it. It is in this fashion, for instance, that a waterspout formed in a liquid vortex loses its individuality and disappears in the ocean." We cannot do better than quote the paragraph with which M. Le Bon closes this section of his book.

The Atom's Secret. "It is, without doubt, so also with ethereal vibrations. They represent the last word in the dematerialisation of matter, that which precedes its final annihilation. After these fleeting vibrations the ether returns to a state of repose, and the matter has definitely disappeared. It has returned to that original non-existence whence only hundreds of millions of centuries and unknown forces can make it emerge anew as it already emerged remote ages before, and whither steal away into universal chaos the first traces of our universe."

And in taking leave of him we may also quote the final paragraph of his book :

"It is in this atomic universe, of which the nature was so long unknown, that we must seek the explanation of the greater part of the mysteries which surround us. The atom, which has not the eternity allotted to it by ancient beliefs, derives its power otherwise than from the properties of indestructibility and immutability. It is no longer an inert something, the blind sport of universal forces. On the contrary, it creates those forces. It is the veritable soul of all things. It holds in check energies which are the mainspring of the world and of its inhabitants. In spite of its insignificant minuteness, the atom, perhaps, holds all the secrets of infinite grandeur."

Continued

GEOMETRICAL DESIGN

Borders. All-over Patterns on Triangular Net Foundation. Enclosed Ornament for Square, Octagonal, and Circular Panels

Continued from page 2322

By WILLIAM R. COPE

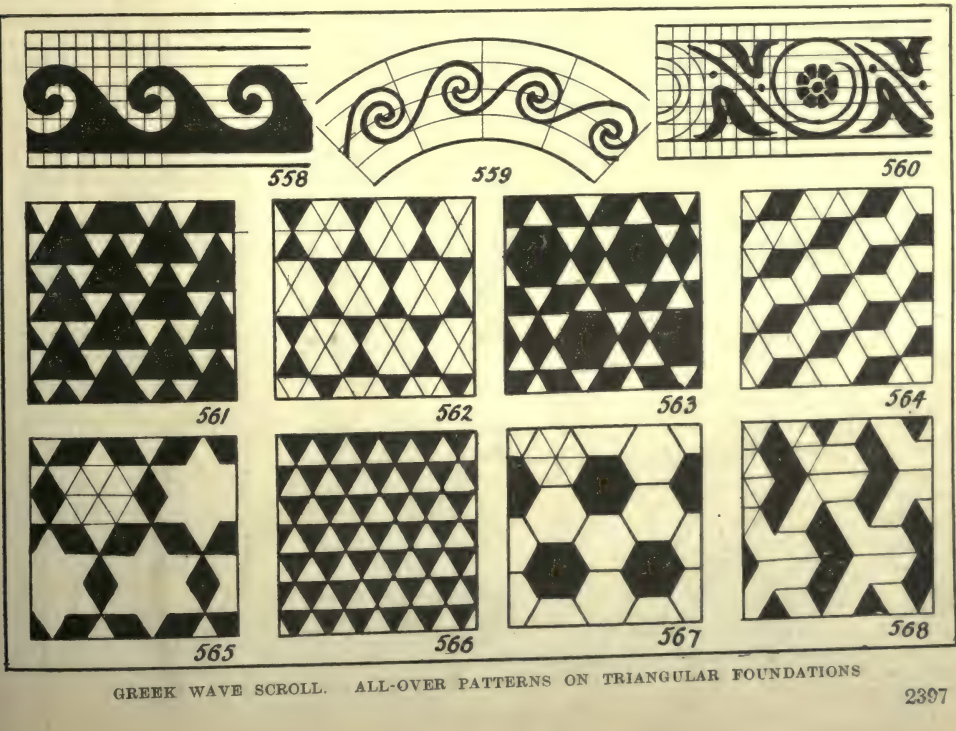
Application of Borders. The proper application of Bands is to the enclosing of ceilings, walls, floors, panels, on certain architectural constructions, on the abacus and plinth of columns, and as a running ornament round the shaft of the latter. They are also used as the hem or border of garments, carpets, and other textiles, on the rims of plates or dishes, in typography, etc.

The Fret is specifically Greek ornament, and no doubt of textile origin. It was Greek vase-painting and architecture which gave rise to the variations of the pattern. Among the Romans the fret was used for mosaics on floors. The Middle Ages seldom used this pattern, but the Renaissance revived it in its ancient application, and made new combinations. The pattern is sometimes carried round a circle, an arrangement, however, which is not in accord with its character. Fig. **539** is an example of a Chinese fret, and **540** is a plait pattern. The centres of the circles in the double guilloche pattern in **552** are at the corners of an equilateral triangle, while in **554** they are at the corners of a square or diamond. [See pages 2321–2.]

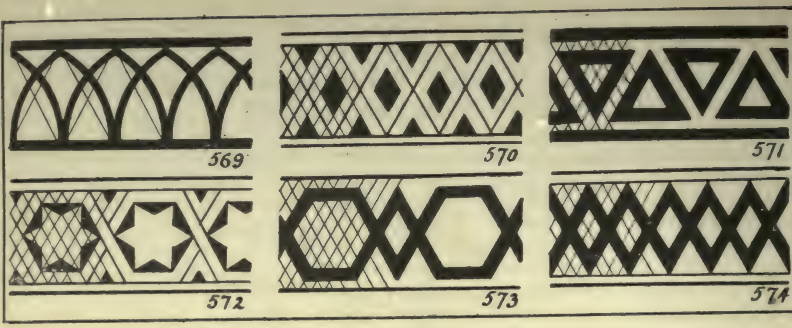
The Greek wave *scroll*, or the evolute-spiral band, is shown in **558** to **560**. The line of this pattern divides the surface of the border into two parts, which in flat ornament are coloured differently. In plastic work, the lower part projects. This border is suitable for robes, shields, plates, friezes, cornices, tablets in architecture, and for other purposes. The rosette is sometimes introduced at the volute centres, and the interstices between the lines decorated with leaves and flowers or buds, as in **560**.

Examples of borders drawn on an equilateral triangular foundation are shown in **569** to **574**.

All-over Patterns on the Triangular Net Foundation. This foundation is easily constructed with the 60-degree set-square and T-square, and may be arranged in two ways, as in **508** and **509** [page 2320]. It is the readiest basis upon which the designer can form "drop" patterns. Many different shapes, such as the triangle, the rhombus or diamond, the hexagon, etc., all make perfectly fitting diapers upon this net, as shown in **561** to **568**. Many designs for parquetry and marquetry may be founded on these lines, and the ornament indicated by the various coloured tiles, stones, or pieces of wood used.



GREEK WAVE SCROLL. ALL-OVER PATTERNS ON TRIANGULAR FOUNDATIONS



BORDER PATTERNS ON TRIANGULAR FOUNDATIONS

Enclosed Ornament. This is ornament designed to fill a definite bounded space, such as a square, an oblong, a circle, etc., according to artistic rules, so that it fits exactly into this space alone. The space is sometimes called a "panel." Besides the square, oblong, and circle, other shapes, consisting of the regular polygons, the ellipse, the lunette or semicircle, various forms of the spandrel, the lozenge, and the triangle are most commonly used as panels.

Position of Panel Ornament. When the enclosed space has the design arranged symmetrically on both sides of one axis, the panel is suitable for a vertical position. When it is developed regularly in all directions from the centre of the shape, and is symmetrical to two or more axes (multi-symmetrical), the panel is suitable for a horizontal position, as in **575** to **595**.

The Square Panel. The two diagonals and the two diameters are the lines on which the decoration of the square may naturally be based, and they form an eight-rayed star with rays alternately of unequal lengths, dividing the figure into eight equal spaces. Numerically, this mode of planning the decoration is predominant. The design shown in **575** is the Uraniscus, an ornament used in the coffers of Greek ceilings; the rays were gold on a blue ground. The patterns in **576** and **579** are examples of inlaid work of the fourteenth and fifteenth centuries. Fig. **578** is an arrangement suitable for ironwork, while **580** is the planning out for a tile design used in mediæval times, but trefoliated forms were also added to this linework.

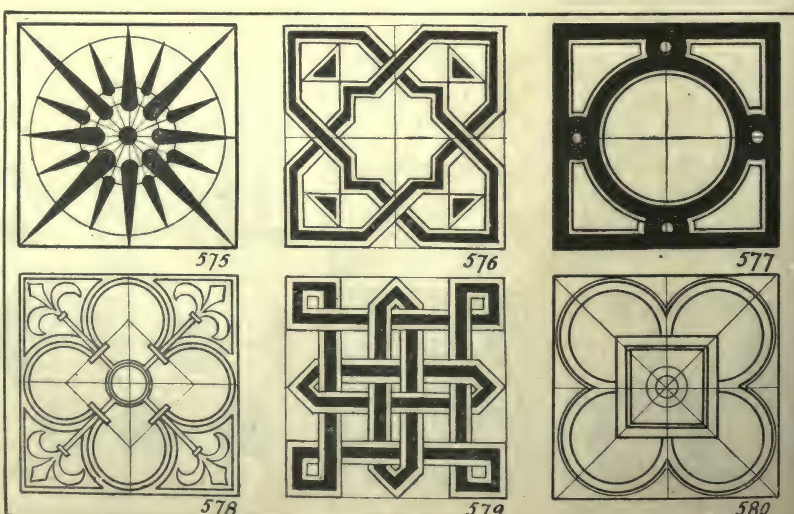
Another kind of decoration for squares is that in which it is subdivided into separate spaces, as in **581** to **589** and each space, may receive independent ornament. It will be noticed that these are much used for panels in ceilings. The panelling in **586** is constructed by dividing the square into 16 smaller squares, and then drawing lines from the middle points of the sides of the large square at an angle of 60 degrees.

The Octagonal Panel. This may be easily constructed within the square as shown in **590** to **592**, or within a circle. The diagonals and diameters intersecting again give a great variety of subdivisions.

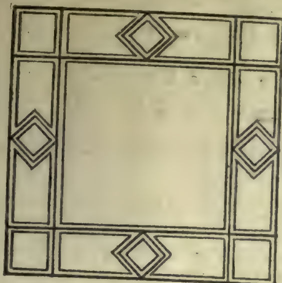
The Hexagonal Panel. This is best constructed within a circle, and may be subdivided in a similar manner to the octagon. Many variations of the six-pointed star may thus be obtained.

The Circular Panel. This shape is usually subdivided into 3, 4, 5, 6, 8, 10, 12, or 16 similar parts, by lines radiating from the centre; or it may be divided into zones, with each belt-like band decorated independently. The subdivision formed by means of arcs, as in **593** and **595**, are very suitable for this shape, especially when required for tracery.

Continued



ENCLOSED ORNAMENT FOR SQUARES



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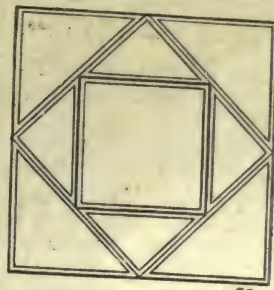

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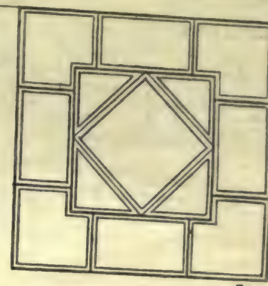

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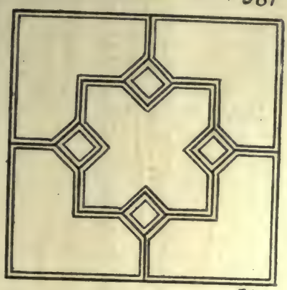

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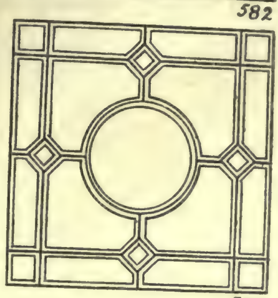

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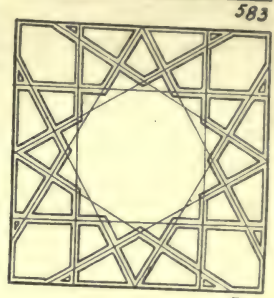

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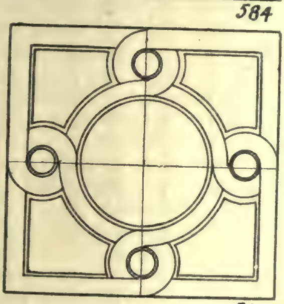

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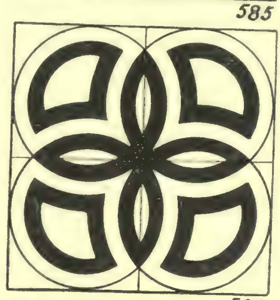

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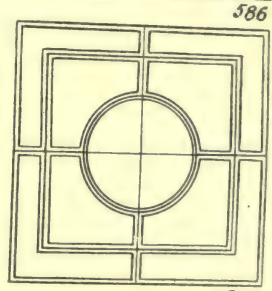

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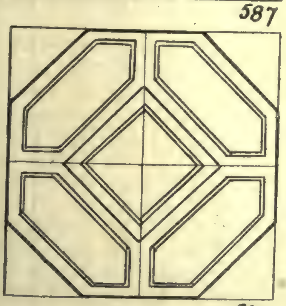

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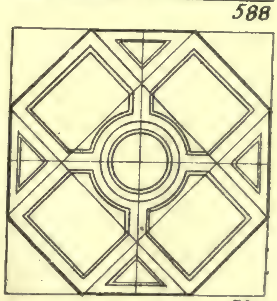

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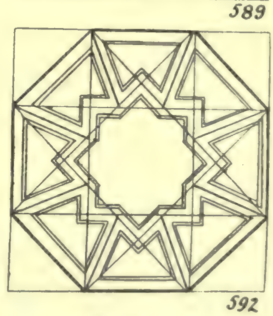

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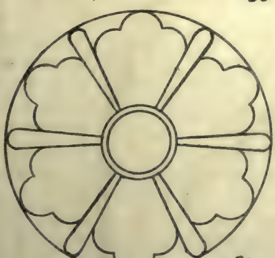

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ENCLOSED ORNAMENT FOR SQUARES, OCTAGONS, AND CIRCLES

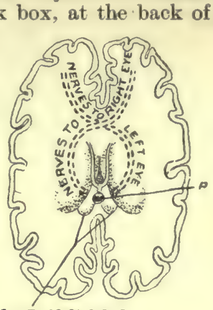
Continued from page 2303

THE EYE

The Eyeball and its Protection. The Eye like a Camera. The Iris and the Pupil. How Colours are Distinguished. Long and Short Sight

By Dr. A. T. SCHOFIELD

The Eye like a Photographic Lens. We have dealt with the main functions of the brain, and it now remains for us to consider the special senses and the faculty of speech. We begin with the eye, and the first thing we should clearly understand about it is that it does not see, and cannot see, any more than a photographic camera. In the latter, the object is focussed through a lens into a dark box, at the back of which it is pictured on a sensitive plate; but the camera does not see —it is the man behind the camera who sees. He peers through the ground glass at the back, and sees the object mirrored there. Of course, it may be objected that this is necessarily so, since sight is an attribute of life, and the camera is not alive. This is true, but nevertheless the illustration is of force because it is difficult to realise that the eye by itself is exactly like the inanimate camera, alive though it be, only receiving and reflecting the images, and that it is the brain behind the eye which really sees.



126. SECTION OF THE BRAIN
Showing position of pineal gland (p) and nerves of sight

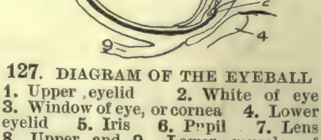
The Real Centre of Sight. We have already noted that the "optic lobes," the real centres of sight by which we see, lie in the base of the brain [126, 133] just in front of the pons in the medulla. These lobes are directly connected, each of them with both eyes; and if one lobe be destroyed, total blindness of the opposite eye ensues, while if both are destroyed, complete blindness ensues, though all images are pictured on the two eyes or "cameras" as perfectly as ever, and that, too, by vital, and not merely chemical processes. This is seen in cases of disease destroying these lobes, which are therefore the psychic centres of sight. In exactly the same way the ear does not hear, nor the tongue taste, nor the nose smell.

The Eyeball and its Protection. Each eyeball is a hollow, flattened sphere, about 1¾ in. in diameter, lying in a pyramidal bony cavity known as the orbit. This is filled with fat, in which the eyeball rests as on a cushion, and revolves freely in a capsule without the least friction [127]. This orbit protects the eyeball from any ordinary injury in front, where it is very strong; but behind the eye its walls are very thin, so that the point of an umbrella thrust into the socket might easily enter the brain, and yet an iron hat-peg nearly 3 in. long has been extracted from the orbit, where it had lain for some days without causing much inconvenience! Another patient, some time after threshing wheat, suffered some pain in the orbit, and discovered in the corner of the eye a grain of wheat that had shot forth a tiny green sprout. The eyeball is still further protected by the *two eyelids*, the upper of which, at any approach of danger, closes down involuntarily in front of the eye. Above and on the outer side lies the *lachrymal gland*, and every time the eye winks a tear is squeezed out of it and sweeps across the eye, washing all impurities away, and leaves the eye by a little duct leading into the nose. This takes place about five times a minute. Only when the tears are rapidly excreted under the influence of emotion do they roll over the lower lid and we are said to "cry." Tears are not secreted before six months—infants, therefore, do not really "cry."

Six muscles are attached to the sides of the eyeball by small white tendons, so as to pull it in every direction. One of these tendons which rolls the eye upwards runs through a perfect little pulley in the top of the orbit [128].

It is of the utmost importance that both eyes should move together, and this has been secured by a similar nerve supply to both eyes—an arrangement that is generally, but, as we shall see, not always successful. When it fails, we squint.

Why Both Eyes See the Same Object. The two eyes are, of course, the sole cause of *stereoscopic vision*, by which two pictures from slightly different points of view are combined into one, thus giving the sense of space or solidity—in short, truly picturing the world of three dimensions in which we live. Had we but one eye, we should see everything in the same plane in two dimensions only, and find it very difficult to understand solidity.

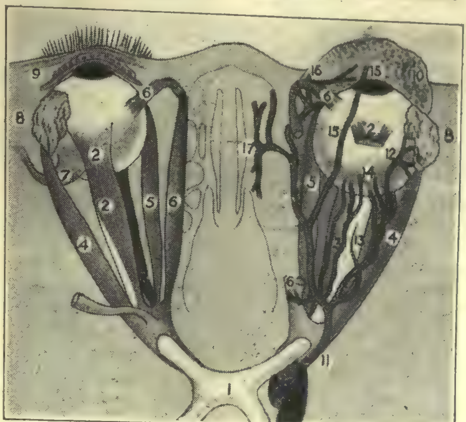


127. DIAGRAM OF THE EYEBALL
1. Upper eyelid 2. White of eye 3. Window of eye, or cornea 4. Lower eyelid 5. Iris 6. Pupil 7. Lens 8. Upper, and 9. Lower, muscle of eyeball 10. Black screen behind retina 11. Yellow spot 12. Nerve of sight

In front of the eyeball is inserted a circular, transparent membrane called the *cornea* [129], through which all light enters the interior. It is apparently "let into" the eyeball, exactly

as a watch-glass is let into the face of a watch. It is really, with the rest of the outer coat of the eyeball—called the sclerotic—comprised of very tough fibrous tissue. In the cornea alone the cells are perfectly transparent, and are arranged in perfectly parallel rows, and there are no blood-vessels.

Mechanism of the Eyeball. It is difficult, as we look at this transparent, glass-like structure, to believe it is composed of about 100 layers of living cells. The surface consists of a false skin, exactly like the epidermis of the body, with the same active life going on every hour. The substance beneath is a mass of transparent, flat, fibrous bands, with irregular spaces between them. These spaces are filled with white corpuscles from the blood—a matter of great interest, because here their movements can be most closely watched during life. If a little aniline dye be injected into the leg, after a time some part of the cornea may be tinged with the colour through white corpuscles which have absorbed it into their bodies having made their way to the eye.



128. THE TWO EYEBALLS FROM ABOVE, SHOWING THE MUSCLES AND BLOOD-VESSELS
1. Optic chiasma 2. Superior rectus muscle 3. Inferior rectus muscle 4. External rectus muscle 5. Internal rectus muscle 6. Superior oblique muscle 7. Inferior oblique muscle 8. Lachrymal gland 9. Eyelid in cross section 10. Eyelid inner surface 11. Ophthalmic artery 12. Lachrymal artery 13. Central artery of retina 14. Ciliary arteries 15. Supra orbital artery 16. Frontal artery 17. Nasal artery

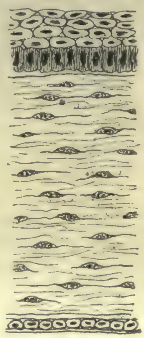
It is evident that on the perfect transparency of the cornea all sight depends, for at the present time, when once the cornea has become opaque, no means is known of restoring the sight. The eyelids are lined with a delicate skin called the conjunctiva, which is continued all over the eyeball, and whose anterior layers form the epidermis of the cornea.

The Iris and the Pupil. On the inner side of the cornea is a *small chamber*—like the space between the watch-glass and the watch—filled with a *clear watery fluid*, called the aqueous humour. The chamber is bounded behind by the iris, a coloured muscle with a contractile circular aperture or diaphragm, through which the image to be seen enters the eyeball. The two irides are not always of the same colour, and brown spots are frequently seen upon them. In albinos they are pink, because, having no colour, the blood is seen through them ; and as too much light thus enters the eye, these individuals see best in the dusk. The pupil or black hole in the middle of the eye varies in size according to the amount of light and distance of the object. It cuts off all superfluous light, so that the image is defined sharply and clearly. The muscles of the *iris* can contract the aperture or *pupil* to a pinhole, or expand it to one-third of an inch. The pupil only looks black because the interior of the eyeball is dark. Its average size is $\frac{1}{8}$ in., and the centres of the pupils should be $2\frac{1}{3}$ in. apart. In a dark room, or when looking at objects a long way off, the pupil is expanded, and it is contracted in bright light or when looking at near objects. This far-away look, from gazing at distant objects, by expanding the pupils, increases the beauty and "depth" of the eye, and is sometimes cultivated artificially, and often depicted in sketches of female heads. Certain drugs, such as atropine, enlarge the pupil, also fear, weakness, and alcohol. Other drugs, such as the Calabar bean and opium, contract the pupil. In men, the muscle acts involuntarily, but animals that prey by night, as cats and owls, can use it voluntarily.

The Focus of the Eye. Just behind the "iris," or coloured curtain of the eye, lies the *crystalline lens* [**130**], by which all images are brought to a focus on the back of the eye. This lens is *bi-convex*, and about half an inch in diameter, and its effect can be seen by focussing any view or object on a white sheet of paper, with a similar lens. The distance of the lens from the paper requisite to produce a clear focus on the paper is determined by the distance of the object, the whole variation being, however, very slight, the length of the focal distance between an object 20 ft. off and one 4 in. being only $\frac{1}{10}$ in. In the camera, where the image of the sitter has to pass through the lens on to the ground-glass or sensitive plate at the back, the length of the focus is adjusted by moving the lens backwards or forwards with a screw until the focal length is arrived at, and a clear, sharp, reversed image of the object is obtained. In the eye the lens is fixed, and the sensitive screen that receives every image is also fixed, about $\frac{3}{4}$ in. behind it.

Near and Distant Objects. To understand the focussing of the eye, one or two points must now be made clear. All vision is divided into "far" and "near." All objects over 20 ft. are "far" or "distant," all others are "near." In the normal eye, the rays of light from each object over 20 ft. distant being parallel, are naturally focussed on the eye by the lens, the only adjustment needed being, as we have shown, an enlargement of the pupil to admit more light. Objects under 20 ft. require what is called accommodation, as rays of light from these are divergent. This is an operation performed unconsciously and exactly, according to the distance of the objective from the eye. Whether an object is 30 ft. away, or 30,000,000

miles, no change in the eye is needed to see it, but a great change in the eye is needed to see an object at 10 ft., and another at 2 ft. The change required is threefold; the pupil is contracted and the two eyeballs converge—a slight inward squint—according to the nearness of the object, and lastly the lens becomes increasingly convex according to the same law. This is necessitated in the eye when the focal distance is fixed, but is not required in the camera when the focal distance can be altered instead. The more convex the lens, the shorter the focal distance, and the lens is therefore automatically altered according to the distance from the eye of any object under 20 ft.



129.
CORNEA, OR WINDOW OF THE EYE
Magnified section

The lens is of almost perfect elasticity, and a thin membrane stretched across the front of it keeps the anterior surface flatter than the posterior, and a special set of muscles instinctively relaxes this membrane to let the front of the lens become more convex as required. Accommodation, or adjustment of vision, for objects under 20 ft. is therefore a threefold muscular action—namely, contraction of pupils, convergence of eyeballs, and convexity of lens.

Behind the lens is the interior of the eyeball, filled with a *delicate crystalline jelly,* through which the light passes to the back. All the light comes through the aperture in the iris, which, whatever colour it may be on the front, is itself black on the inside, to prevent any rays penetrating into the eye, except by the pupil.

The Nerve to the Brain. The nerve that passes from the brain into the eyeball to the centre of sight is like a stalk to the eye, and is as thick as a small slate-pencil. It does not enter the eye exactly at the back, but $\frac{1}{10}$ in. to the inner or nasal side, and then spreads out into a thin film called the *retina,* $\frac{1}{50}$ in. thick, all over the inside of the eyeball, excepting the anterior third, where no image nor light can ever come. It does not lie immediately in contact with the white "sclerotic" coat of the eyeball itself, for between the two is a layer of cells called the *choroid,* having the appearance of *black velvet,* so full are they of black pigment, which forms an admirable background for the transparent nerve film that lies on it, while it allows no ray of light to pass through.

This nerve film [131], thin as it looks, consists of some dozen most complicated layers of cells of various kinds, the innermost, next the choroid, being a layer of so-called "*rods and cones.*" The rods are filled with a delicate fluid called the visual purple, which is bleached as the light falls on it. They are supposed to give the picture looked at in black and white, while the cones are supposed to be connected with the colour sense, certain of them responding to the red rays, others to the blue, and others to the green or yellow. The retina itself is quite transparent during life, but cloudy and pink after death. Opposite the centre of the lens, at the very spot where all objects are focussed that are directly looked at, there is an elevation called the *macula lutea,* or yellow spot. The optic nerve enters $\frac{1}{10}$ in. to the inner side of this spot. In this spot, all the layers disappear except the cones, and sensitiveness decreases with the distances from it. Thus, 5° away, the sight is only $\frac{1}{4}$ as acute; at 10°, $\frac{1}{15}$; at 20°, $\frac{1}{40}$; at 30°, $\frac{1}{70}$; and at 40°, only $\frac{1}{200}$. Beyond this, vision is imperfect. Every nerve fibre that enters the eyeball by the optic nerve is connected with about seven cones and pigment cells, and 100 rods.

On the rods and cones that lie innermost against the black choroid coat every object from the external world is thus temporarily photographed.

We can "see" many things at once, but we can only "look" at one object at a time—that is, focus it on the yellow spot.

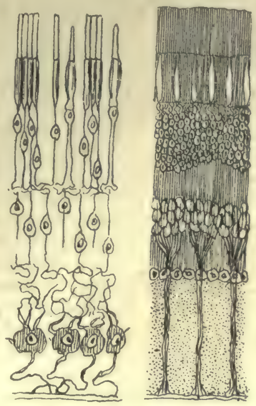
The Blind Spot. As we have seen, *the optic nerve itself cannot receive any image,* and as there can be no retina where it enters the eyeball, so part of every image we see is lost, as if a black hole was punched out of it; only we never notice this, any more than the fact that everything we see is upside down, because we have long since learned instinctively not to notice the small blank part, and also to reverse the visual image in the mind. But that the "blind spot" exists is proved, as is well known, by closing the left eye, looking steadily at this cross [132], and slowly raising the head up to a certain point; the black dot will be seen as well while you still gaze at the cross, but at a certain height it will suddenly disappear. At this height, while the cross is impressed on the yellow spot, the black dot is just on the optic nerve, and hence is not seen, proving the nerve of sight itself to be blind, and only able to receive objects through the retina.

130. LENS OF THE EYE
1. Lens adjusted for far, 2. for near, objects 3. Cornea 4. Conjunctiva 5. Sclerotic 6. Choroid 7. Ciliary process 8. Suspensory ligament 9. Iris 10. Anterior chamber

The eye gazing at any bright object soon gets exhausted, for the object is not merely mirrored, but positively photographed, as we have shown, upon it. If a rabbit be killed in front of a window in a bright light, and its retina examined, the bars of the window can be seen bleached upon it. Hence, for a time after coming into the house on a dazzling day we are quite blind.

And here let us once more compare the eye with the camera. A photographic artist.

standing by a sensitive camera, looks at the object with his eye, and we may observe the simultaneous process going on in the two. At the same instant that he takes the cap off the camera he may open his own eye wide, and thus takes off the cap or eyelid. The light reflected from the object now streams in at the cornea in the eye and at the opening in the camera. Passing backward in both, the first thing met with in each is the bi-convex lens. This serves to gather up the diverging lines of light from objects under 20 ft., or parallel rays from objects over, and causes them to converge to a focus as they pass in to the sensitive plate in the camera, or the retina of the eye. On each, they at once bleach the object reversed. Here, in the camera, the process ends; in the eyes, the image is at once conveyed along the optic nerve to the centre in the brain, which "sees" it.

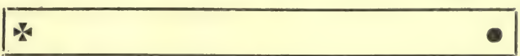


Separated nerve fibres — Section of retina

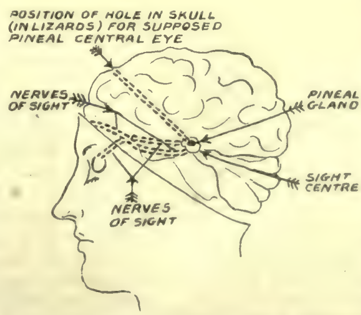
131. RETINA, OR FILM OF NERVE OF SIGHT SPREAD OVER INSIDE OF EYEBALL
Showing rods and cones and nerve cells and fibres

The eye has one great advantage over a camera, in having a *curved* retina equidistant in every part from the lens. The camera has a *flat plate* and can only therefore perfectly focus a very small part at the same time.

How the Eye sees Colours. Light itself consists in the movement of *luminous waves of ether* travelling at a speed varying from 446 to 667 billions of feet per second, *red waves* being the *slowest*, and *violet* the *most rapid*, *green* occupying a *middle place*. This perhaps accounts for the rest that green gives to the eye, for being of a middle tone its vibrations are not so fatiguing as those that are very rapid or very slow. The variations in light waves are, however, much more limited than sound waves. Each colour is caused by waves of light of a definite rapidity, and certain cones seem able to take up only the slowest, or red rays; others the faster, or green or yellow; others the fastest, or blue and violet. The solution of the puzzle on our walls of "Pears' Soap" is thus quite obvious. We stare at the great red letters until all our red cones are exhausted, and we cannot see with them; then, if we turn our eyes away, though the whole image of the "Pears'" is fixed for a time on the retina, the red cones being exhausted, we only have the blue and yellow left, and hence see it as green. Of course, if the red were not exhausted, and we turned away, we should not see it in any colour at all, for all colours together make white light.



132. DIAGRAM TO SHOW BLIND SPOT IN THE EYE



133. SIDE VIEW OF BRAIN
Showing position of pineal gland

Colour-blindness. Colour-blindness is not at all uncommon, and in some cases is most dangerous, particularly in railway employees, for red-blindness, which is the most common in engine-drivers and others, might lead to fatal consequences. Prolonged smoking of strong tobacco often causes such red-blindness, so that no difference can be seen between a red rose and its leaf. Colour-sight, like all else in the body, increases by practice, the cones being, of course, living cells. It is found to be *better in women than men*, as they have for generations been occupied with the study and discrimination of bright colours. The bright light of sunshine is 60,000 times stronger than the moon at full, or a bright candle at a distance of one yard, and soon exhausts the eye.

Keen Vision. Acuteness of vision is dependent not only on a perfect eye-camera, but is partly psychical and due to long practice, and is therefore, like all other qualities, hereditary.

Four thousand years ago the Arabs named a small star in the tail of the Great Bear, now just visible, "Saidak," or the Tester (of sight), and to-day their vision is wonderfully keen. Indian guides have been known to distinguish the figure of a man against the skyline eighteen miles away. Of course, in such an instance, a great deal depends on the amount of light falling on the object, and on the purity of the air. Dwellers in towns, on the other hand, have very short sight, as have those who have to gaze entirely at close objects.

Results of Disuse. The eye also wastes away if not used, like any other organ, as is seen in the eyeless insects and spiders in the great caves of Kentucky. It also enlarges to an enormous size when the light is poor, as in those fish that swim at great depths. It is curious to note that in soles and all flat fish one of the eyes travels through the head. These fish are constructed to swim vertically like all others, but they soon begin to lie and to swim flat on one side. At first, soles, like salmon or trout, had a right and left eye, but it is obvious that with constantly lying on the side the lower eye would always be buried in the mud. The eye itself travels through the head and comes out by the side of the other eye; so that all flat fish have two eyes on the one (upper) side.

Continued

Group 17
APPLIED EDUCATION
6
Continued from page 2307

INTELLECTUAL FREEDOM

Rational Freedom and Openness of Mind. Life must have Definite Aims. The Bearing of History on Life. Contact with Affairs a Cure for Intolerance

By HAROLD BEGBIE

MR. JOHN MORLEY has written contemptuously of "our lofty new idea of rational freedom as freedom from conviction, and of emancipation of understanding as emancipation from the duty of settling whether important propositions are true or false."

One of the most certain effects of study upon the mind is determination of opinion. A man cannot read an admired author without receiving something of the bias of his master. As we proceed in our studies, so we are moulding and fixing our opinions. It seems almost impossible that a man should read diligently and remain in precisely the same state of mind concerning the direct and indirect subjects of his inquiries.

And yet rational freedom is to be desired. Not the rational freedom of the man of the world, with "his inexhaustible patience of abuses that only torment others; his apologetic word for beliefs that may, perhaps, not be so precisely true as one might wish, and institutions that are not altogether so useful as some might think possible"; not this false and unworthy freedom of reason, but the true and just openness of mind which effectually preserves the student from the fierce and cramping effects of bigotry.

The problem, therefore, is how to cultivate this rational freedom and openness of mind, and at the same time confirm and strengthen resolution, energy, and devotion to principles. What we have set ourselves to compose is a suggestion which has for its end intellectual freedom combined with energy of action.

The Broad Principles of Life. Now, there are certain broad and definite principles of life which happily admit of no equivocation, and upon which every man—if he questions himself—will find that he holds opinions quite as definite. For instance, a man will know whether he believes in the humanitarian principle of doing unto others as he would they should do unto him; or, whether he believes in the laws of the forest, whereby selfishness becomes an intelligent creed. On these broad and definite principles of life it is necessary that the opinions he holds should be boldly and faithfully announced in his own mind. He may be uncertain whether Conservatism or Liberalism better serve the interest of the humanitarian principle; but he must not be in two minds as to whether Freedom is better than Tyranny, or Equal Rights better than the Law of the Strongest. On the broad principle he must hold definite opinions. There is no question here of bigotry or intolerance; it is a question of aim, of direction, a question of aspiration and character.

If a man conscientiously believes that the humanitarian principle is a delusion, and that all the travail and heavy labour of the world are due to man's sentimental notion of striving to introduce love into a brute universe, he cannot be accused of intolerance in holding this opinion and striving for its acceptance in the world. But if a man holding this opinion is moved by compassion to give money for the relief of distress, or puts his own life at the risk in order to save a life which can bestow no possible advantage upon his—then, even while his tolerance is praised, he confesses himself neither intellectually free nor courageous in his character.

Need of Definite Aim in Life. In the beginning, then, we suggest that it is above all things necessary for a man to determine his attitude towards life. Before he picks up the tools of energy he must know what he would fashion. Even if he finds himself unable to determine whether the world was made consciously or unconsciously, even if he finds himself unwilling to subscribe to the idea of a life beyond the grave, still he must determine within himself—if he would save his life from perilous drifting—what it is he earnestly desires to do with his existence. In other words, he must be aware within himself of a direction and an aim in his life. He must possess a general principle of conduct.

Given this direction and aim in life, we must proceed to discover how study and experience may be prevented from hardening the intellect in any one single inclination. For instance, if a man entertains humanitarian principles, we must discover how he may save himself from an exclusive devotion to any one particular panacea for human ills—such as the gospel of a particular sect of Christianity, or the creed of the philosophical vegetarian.

The Study of History Ensures Tolerance. The first of all studies which makes for a wise tolerance is History. The path of human progress is strewn with the skeletons of forgotten causes. No one particular view of a thing has ever held an eternal field. Men are for ever setting up banners and erecting temples, and for ever the movement of humanity leaves those tattered flags and those ruined temples far behind the march of to-day. The reason is obvious, and an apprehension of this reason is the surest safeguard of an open mind and freedom of intellect. Life is a gradual revelation of truth. We penetrate every day a little further into the mysteries of Nature. At no single time has truth made an absolute revelation of itself. The outlook of every day is a little wider. To build a temple with every fresh

aspect of truth is natural—for enthusiasm is one of the driving forces of the world—but it is unphilosophical, it is irrational, and it must fail. Humanity can no more stop at what is called "Darwinism" than it could stop at the Inquisition. The philosophy of Plato can no more satisfy the cravings of human reason than the counsels of Lord Chesterfield. To believe that any one set of opinions can ever hold the field is to say that knowledge is exhausted, that it has discovered all there is to be discovered, and that the race can progress no further. Intelligent reading of history, then, will always check the student from erecting hasty temples to his partial apprehensions of truth. He will balance his enthusiasm for to-day with his respect for the possibilities of to-morrow. He will never be in a hurry.

False Intellectual Freedom. But it is quite possible that the student of history may find himself the victim of that false freedom of intellect so eloquently condemned by Mr. Morley. He may be so paralysed by the tremendous spectacle of lost causes and ruined aspirations strewn across the road of universal history, that he will sit with folded hands and profess himself unable to strike any blow in the conflict of his day. He will have an open mind, but an empty mind. He will have no fixed opinions ; he will have no opinion at all.

The way out from such a paralysis of intellectual energy lies, we think, in a devotion to the practical affairs of life. The student who remains in his closet is always in danger of this paralysis. But let him come from his books into the actual world of existence, let him make himself acquainted with the lives of men and women, let him, above all things, endeavour to see the problems of existence from the standpoint of those whose circumstances are different from his own, and it is certain that he will shake off his paralysis of will, and find himself determined in certain definite directions regarding his opinions and his conduct.

The Secret of Voltaire's Power. "Voltaire's books," says Mr. Morley, "would not have been the power they were but for this constant desire of his to come into the closest contact with the practical affairs of the world. He who has never left the life of a recluse, drawing an income from the Funds and living in a remote garden, constructing past, present, and future out of his own consciousness, is not qualified either to lead mankind safely or to think in the cause of human affairs correctly. Every page of Voltaire has the bracing air of the life of the world in it, and the instinct which led him to seek the society of the conspicuous actors in the great scene was essentially a right one."

"Let no one," says the sage Guicciardini, "trust so entirely to natural prudence as to persuade himself that it will suffice to guide him without help from experience. For there is no man, however prudent, who has been employed in affairs but has had cause to know that experience leads us to many results we never could have reached by the force of natural intelligence alone."

We believe, then, that the student who would combine intellectual freedom with energy of opinion must be something of a man of affairs. He must trust less to intuition and more to actual experience. He must know more of life than of literature. It is one of the regrettable characteristics of modern life that municipal authority should lie so very largely in the hands of ill-educated, and therefore prejudiced people; while the scholar and student remain behind the scenes, wrong thinkers and wrong citizens. An active realisation of the duties of citizenship would contribute more to the authority of the philosophers than many libraries of their meditations.

There is, however, as we may see from the biographies of famous men, always a danger of intolerance. The student who takes part in civic life, the philosopher who becomes a statesman, do not always preserve their intellectual freedom. Their intolerance may not be a danger to the State, and may not prove a serious bar in the path of their own intellectual progress, but it cannot be said of them with propriety that they enjoy ample freedom of intellect. They have subjects on which they are "cranks"; they have opinions on which they are bigots.

Intellectual Freedom a Rare Virtue. It may be said at once that there will always be people in the world ready to describe as a crank any man whose opinions differ from their own ; but we are ready to admit that intellectual freedom is one of the rarest of virtues in human society. And, further, when we examine the question more closely we are puzzled to decide whether the intolerants have not done rather more for human progress than the tolerants. Wherefore the conclusion we come to is in the nature of a compromise. We believe that a man may enjoy intellectual freedom under a general and steadfast principle of conduct ; we hold that a study of history and acquaintance with actual life conduces to this end ; and we argue that intense devotion to a set of opinions may be justified, even when it seems to fetter freedom of intellect, if its effect upon the world is in harmony with a beneficent principle of conduct.

To realise that every day we approach nearer to the truth of which we shall never actually lay human hands upon is to convince the mind of the extreme value of modesty and tolerance ; and this is the true benefit of intellectual freedom. Howsoever eagerly and firmly we may embrace one set of convictions, if we are modest in our beliefs and tolerant towards the beliefs of other people, we shall not greatly miss the calm and serenity of intellectual freedom. the inexpressible satisfaction of an open mind.

Continued

RUSSIA

Russia's Inland Sea Coast, Flat Surface, and Large River Basins. Climate. Zones of Vegetation. Industries. Baltic Lands and Poland

By Dr. A. J. HERBERTSON and F. D. HERBERTSON, B.A.

Boundaries. European Russia (2,100,000 sq. miles) stretches eastwards from an artificially determined land frontier with Norway, Sweden, Germany, Austria-Hungary, and Rumania, to the confines of Asia. Its northern shores are washed by the Arctic Ocean and its gulf, the White Sea, on which is Archangel, long the only Russian port, closed by ice for half the year. On the Baltic Sea, in the north-west, are the ports of St. Petersburg, Revel, Libau, and Riga, of which only Libau is always open. In the south the Black Sea, with Odessa as its chief port, communicates with the Mediterranean, an advantage lessened by the fact that Constantinople commands the only exit and entrance. The land-locked Caspian facilitates communication and trade with Persia on the southern shore and with the Russian dominions in Central Asia.

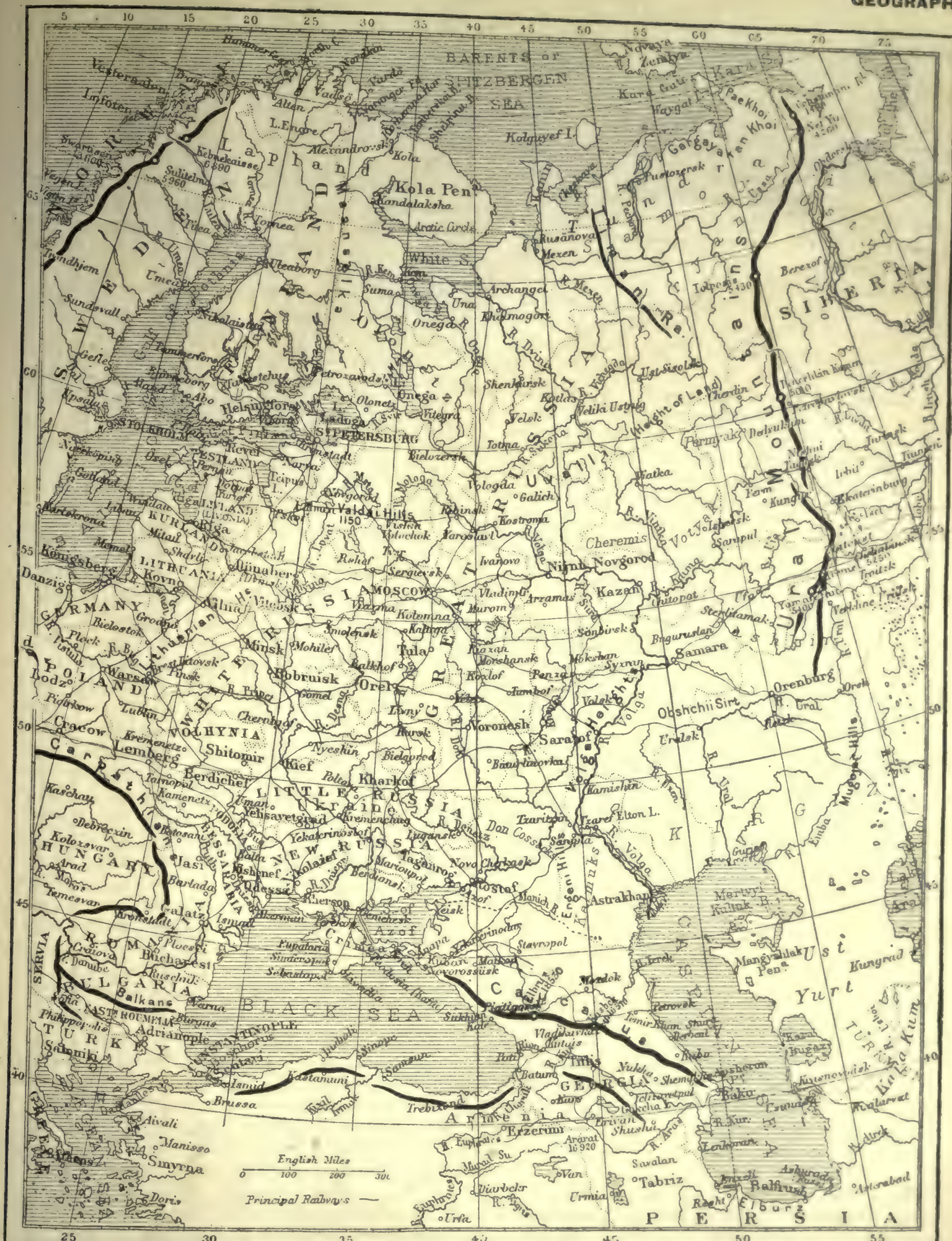
A Surface Nearly Level. Russia has no striking contrasts of highland and lowland. It is an undulating plain, generally over 300 feet above sea level, crossed by a broad belt of higher ground which rises in the Valdai Hills to 1,100 feet, and forms the divide between the rivers flowing to the Arctic and those flowing to the Baltic, Black, and Caspian Seas. The Urals, which form part of the boundary between Europe and Asia, consist in the south of parallel ridges rising to 4,500 ft., but are less definite in the north, where, in spite of an elevation of 5,000 ft., they may be regarded as a continuation of the central belt of elevation. They are extraordinarily rich in minerals, including iron, and the forests supply all the timber needed for smelting it, as well as an immense surplus for export. This is made up into huge rafts, which are floated down the Kama and its tributaries to the Volga. The Caucasus, which forms the frontier of Europe between the Black and Caspian Seas, rises in Elbruz to 18,000 ft., and contains many extinct volcanoes. The scenery rivals that of the Alps in beauty, glacier and snow-peak rising above the beech forests and pastures which clothe the lower slopes.

Russia's Big Waterways. The rivers of Russia, though they diverge to widely distant seas, rise near each other at the same level, and often in the same vast marshes. Flowing across a region with no strongly marked natural features, their courses often approach each other, so that it is easy to traverse the country from end to end by water, the boats being carried for a short distance across the low, marshy land which separates one river from another. Canals connect the various rivers, so that there is a continuous waterway, for example, between St. Petersburg on the Baltic and Astrakhan on the Caspian.

Look out on the map the sources of the North Dvina, flowing to the Arctic ; the Volga, flowing first east and then south, round the base of low heights, and across sunken plains to the Caspian, which lies below sea-level ; the Western Dvina, flowing west to the Gulf of Finland ; and the Dnieper, which flows south to the Black Sea, and helps to drain the great Pripet swamp, the rest of whose waters are carried to the Baltic by the Vistula. Between the Vistula and the Western Dvina is the Niemen, whose chief tributary rises only a few miles from a tributary of the Dnieper. All these rivers are near each other either at their sources or in other parts of their course. The country between the Dnieper and the Volga is drained to the Sea of Azov by the Don and its tributary, the Donetz. Notice the close resemblance between the lower courses of the Dnieper, Don, and Donetz, and how this eastern trend brings the Don within 40 miles of the Volga, rendering communication between the Caspian and Black Seas easy and cheap. The other rivers to note are those from the Urals, the Pechora, flowing north to the Arctic, and the Ural, south to the Caspian, forming part of the boundary of Europe.

Climate. In Russia we have a typical continental climate, dry and extreme, especially in the east. The rainfall of Russia is everywhere scanty, except in the Western Caucasus, and the districts round the Caspian are almost rainless. Look back at the climate maps of Europe. The great southern sweep of the winter isotherms means that everywhere the winter is long and severe. A hundred years ago Russia utterly defeated the great Napoleon by the aid of two invincible generals, General January and General February. There are no high hills to break the winter gales which sweep across the country with irresistible force, making the winters of such neighbouring countries as Rumania much more severe than if mountains intervened. Snow covers the whole country for many weeks, and the frosts become more intense and protracted as we go east. The rivers are frozen for six months in the north, three or four in the centre, and for eight or ten weeks in the south. At Astrakhan, in the latitude of Lyons, the ice lasts 90 days ; while at Warsaw, on the Vistula, which, though much further north, is also further west, it lasts only 77.

The Coming of Spring. After this long winter, spring comes and goes in a flash. " The sound of many waters is heard everywhere as the melting snow flows down to the low-lying fields, converting miles of country into a shallow lake, in which the farms and villages built on a little higher ground seem an archipelago of islands. For ten days or a fortnight all communication



102. RUSSIA

ceases with the outer world." Almost immediately it is the height of summer. "A few days after the frost has disappeared the trees are all in leaf. Within the space of a few yards I have often seen the ground a blaze of flowers and butterflies and dragonflies skimming over heaps of snow that the fierce rays of the sun have not had time to melt." The summer is hotter in the south than in the north, and in the east than the west. So precious is the summer that many peasants, all of whom own a fraction of the soil, hasten from the factories where they have spent the winter to sow and reap from dawn to dusk, returning to the mills when the leaves begin to fall and the night frosts tell of returning winter.

Zones of Vegetation. Russia extends across the whole breadth of Europe, and has all those zones of vegetation which we have so far

seen only separately. In the north is the tundra, but on a vaster scale than in Norway or Sweden. Across a desolate, treeless, marshy plain, buried half the year in snow, the rivers creep to the Arctic. Fishing in river and sea is important in summer, and in winter timber is cut, and fur animals are hunted in the forest to the south. The preparation of timber, tar, pitch, furs and tallow from the forests, and of train oil from the Arctic fisheries are the chief occupations. Archangel, the port of the tundra, trades in all these.

The coniferous forests of Sweden and the deciduous forests of Central Europe are found in Russia on a magnificent scale. Villages and towns are built in the clearings, and all around lies the boundless forest, with the river as its highway. [103.]

South of the forest belt are the agricultural lands, passing into rich steppes like those of Hungary and Rumania, but infinitely greater in extent. On the margin, the landscape is broken by small woods, but the true steppe is treeless, and grass or ploughed lands extend to the horizon. Much of the steppe is covered with rich black earth of inexhaustible fertility. Its beauty and fascination for the steppe dwellers have already been described.

Finally, beyond the steppes comes what is not found elsewhere in Europe, the beginning of the desert in the dry, salt plains round the Caspian. This region is as thinly peopled as the tundra, and offers as little to its inhabitants.

Occupations. The uniformity of the surface has its counterpart in the lives of the people, among whom we find little of that diversity which marks Western Europe. The occupations of the tundra depend on the fisheries and the forest. In the forest regions the forest industries are carried on, with agriculture in the clearings. Agriculture is all important south of the forest zone during the summer, and the cultivated steppes form one of the granaries of the world. In winter those peasants who remain in their villages carry on many industries, often of a highly-skilled character, supplying all peasant and many middle-class requirements. For this, among other reasons, large industrial towns are confined to the coalfields. These are found in Central Russia, round Moscow and Tula, the Sheffield of Russia, in the Donetz basin, and in Poland. The chief manufactures are distilling and brewing, cotton manufacture, sugar refining, tanning and flour milling.

The Baltic Lands. Around the Baltic lies a region of pine-woods and innumerable lakes, large, like Ladoga (7,000 sq. miles) and Onega (3,800 sq. miles), or quite small. Lying north of Ladoga and the Gulf of Finland is the grand duchy of Finland, with thousands of lakes. It is inhabited by a people whose intelligence, love of liberty, and prosperity, in spite of difficult natural conditions, recall the Swiss. The capital is Helsingfors, a handsome city opposite Revel. The latter is one of the ports of the Russian Baltic provinces, also a region of lakes and forests, with flax, hemp and hardier cereals in the clearings. These Baltic provinces are not Russian in blood, and to Russianise them St. Petersburg was built among the desolate swamps at the mouth of the Neva, the foundations being laid on piles. The Neva is frozen for nearly five months in the year. The city is handsomely built on both banks of the river, and is made picturesque by the coloured and gilded clustered domes of the cathedral of St. Isaac and of many churches. Kronstadt, at the head of the Gulf of Finland, strongly fortified, is the station of the Russian Navy, and an outport for the capital.

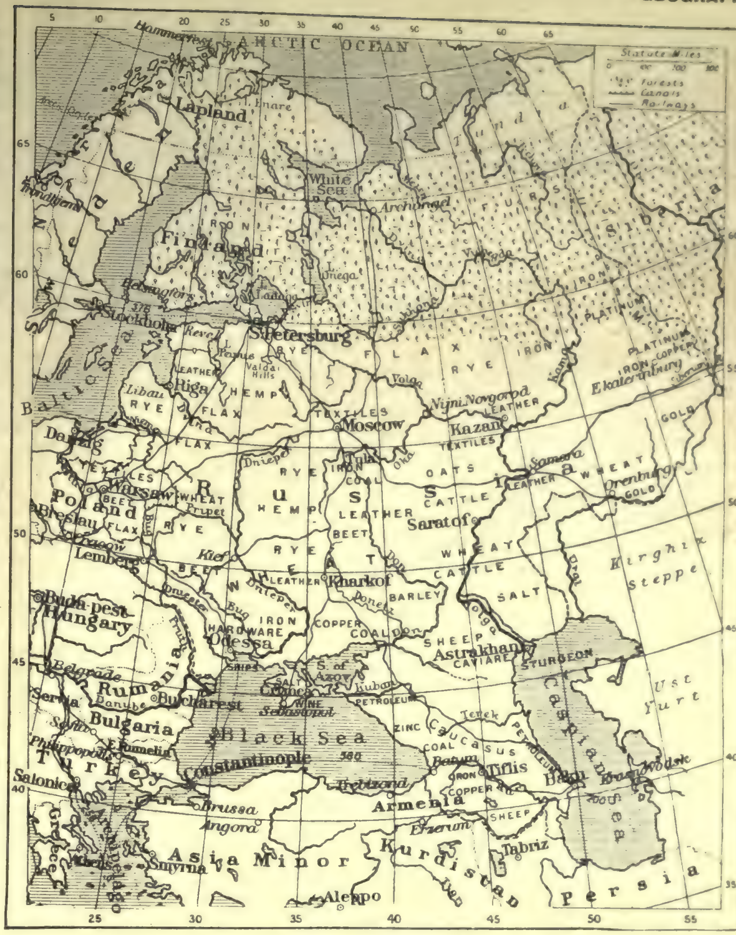
Poland. Poland, also non-Russian both in blood and sympathies, resembles the Baltic provinces in the north, but rises in the south to a densely-forested plateau, intersected by deep ravines. Agriculture and cattle breeding are important, and the forests supply timber, which is floated down the Vistula in great rafts. Coal and other minerals are abundant in the south, where industries are growing rapidly. Lodz, with a large proportion of Germans and Jews, has hundreds of cotton-mills, woollen factories, steam flour-mills, breweries, machine shops, etc. Warsaw, on the Vistula, the old capital, carries on many industries, and with its command of routes in all directions is bound to become one of the most important cities in Europe.

The Dnieper Basin. This lies partly in the unproductive zone of Central Russia, partly in the rich Black Earth belt. The sugar beet is grown round Kief, the chief city of the Dnieper, with sugar refineries, tanneries, woollen manufactures, and flour-mills, all manufacturing the products of the Dnieper basin. Kherson is the port. West of the Dnieper are Nikolaief, on the Bug, with similar manufactures, and Odessa, the commercial metropolis of the region, built on the high edge of the steppe above the Black Sea, and doing an enormous trade in the produce of the Black Earth region. Bessarabia in the south-west resembles Rumania, and has many vineyards.

The Don Basin. The basin of the Don and its tributary the Donetz lies chiefly in the steppe region. Kharkof is the centre of the industrial region on the Donetz coalfield, which draws its raw materials from the steppes. The traffic in goods carried by the Don to Rostof and Taganrog, the ports of the Sea of Azof, is very great, including petroleum and other products of the Caspian, and timber from the Urals, which reach it by way of the Volga. The Crimea, united to the mainland by the narrow isthmus of Perekop, is a steppe land in the north, with a very extreme climate. In the south it rises to the Yaila Mountains (5,000 ft.), the southern valleys of which have the Mediterranean climate, and produce good wine.

The Volga Basin. The Volga, the largest river of Europe, 2,300 miles long, drains with its tributaries a region as large as the British Isles, France and Germany. It rises in marshes in the Valdai hills, and is navigable from Tver, where it leaves the hills. Nijni Novgorod, the scene of an enormous annual

fair, where the products of east and west are exchanged, is built where the Oka comes in on the right bank, having flowed, like the main stream, through a densely-forested region. On a tributary of the Oka is Moscow, the real centre of Russia, with its picturesque Kremlin Hill, crowned with palaces and churches. Further south are the industrial centres of Tula and Orel, on the central coalfield. Below the confluence of the Oka the Volga flows between a high right and a low left bank. Kazan, the former Tartar capital, is on the river only in times of flood. Its industries are characteristic of the steppe towns, including tallow, soap and candle works, and tanneries, utilising the produce of the vast herds of the steppe lands, also flour and starch mills, supplied by the agricultural steppes. The Kama, the chief tributary on the left bank, flows through the mining region of the forested Urals, and brings down the produce of Siberia, including immense quantities of grain and timber, as well as tea from the Far East. The lower course of the Volga is through the wheat land of the steppe. Windmills for grinding flour are everywhere, the country being too flat for water-power. Steam flour milling is also important. The chief towns are Samara, on the left bank, and Saratov and Tsaritsin, on the right. At the latter town, from which a short railway goes to the Don, the river is already 60 ft. below the sea-level. A large branch, the Akhtuba, flows parallel to the main stream, communicating with it across marshy land by many channels. The delta begins 40 miles above Astrakhan, and is crossed by 200 distributaries. The valuable sturgeon and seal fisheries of the Lower Volga and Caspian employ thousands of men. Caviar, a delicacy made from sturgeon roe, is largely exported from Astrakhan. The chief occupation of the Caspian steppes, away from the river, is cattle keeping, carried on by nomadic tribes, who live in tents and follow their flocks and herds from pasture to pasture. Only along the river-banks and in the delta is there a settled population. Astrakhan is the Caspian port of the Volga, and an excellent system of canals in north-west Russia has converted St. Petersburg into its Baltic port, thus giving this immense but remote region an outlet to the markets of Central Europe.



103. INDUSTRIAL MAP OF RUSSIA

Continued

VIOLIN
continued from
page 2314

POSITIONS

The Seven Positions. Half Positions. Higher Notes. "Portamento." Extensions. Four-string Chords. Double Stopping

By ALGERNON ROSE

HITHERTO the hand has been in the normal position, the top C having been played by stretching up the little finger. The hand is said to be in the *First Position* throughout the compass of two octaves up to top B, when so situated that the first finger gives the nearest note above that of any open string. But, above the top C, obtained by an extra stretch of the fourth finger, the left hand of the violinist can stop ten extra notes on each string, those of the two upper strings being of the better quality. The method of fingering this considerable range of additional notes should therefore be thoroughly understood.

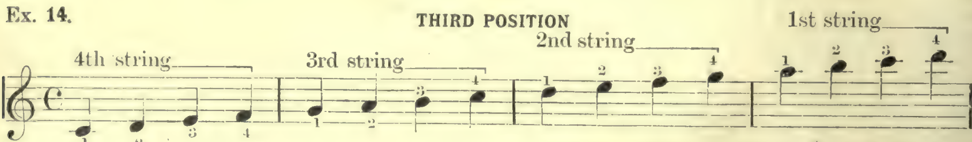
Shift the left hand towards the bridge a note higher than it has been when playing in the normal position. Be careful to keep the wrist well down, and to let the fingers fall perpendicularly on the strings. The hand is now in the *Second Position*, and the third finger no longer represents C on the fourth string, the second finger having become identified with that note. Amongst amateur fiddlers it is a custom to go from the first to the third position without taking the trouble to learn the second. This is a slack habit. The second position is as easy and beautiful as the third, and the student who devotes attention to the former will later on reap his reward.

It will be observed now that the open strings are no longer utilised. The sooner the student gets accustomed to fingering every note the better. On account of the different quality of the open notes, good players use them sparingly, and only when the tones they produce are otherwise unobtainable. We give in Ex. 13 the fingering of the four strings in the second position.

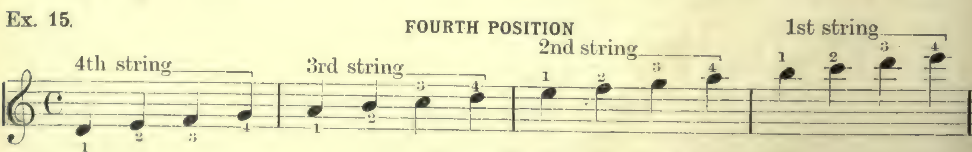
When the hand is shifted up a note still further, it is in the *Third Position*. In this the ball of the left hand rests against the shoulder of the violin, the thumb acting as a brake, so that the hand does not go too far. On approaching the bridge, the student will perceive that the notes lie nearer each other. In consequence, the fingers, especially when stopping

Ex. 13.

Ex. 14.

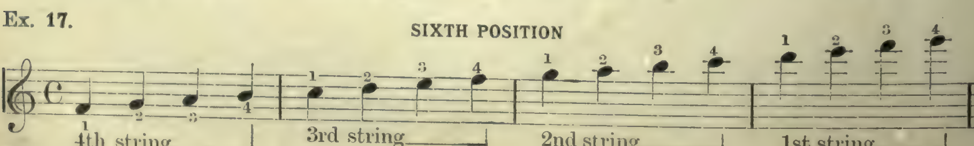


Ex. 15.



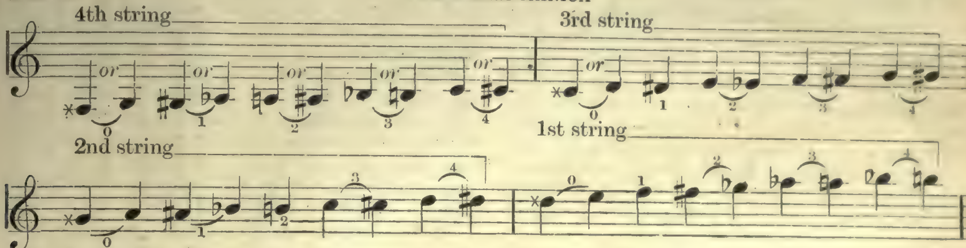
Ex. 16.

Ex. 17.

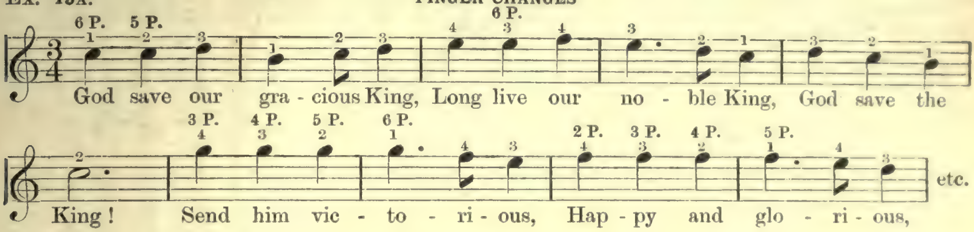


Ex. 18. SEVENTH POSITION

Ex. 19. THE MEZZA MANICA



Ex. 19A. FINGER CHANGES



Ex. 20. PORTAMENTO

semitones, come closer together. Should the player's fingers be thick at the tip, he may therefore, before stopping a half-tone, find it necessary to remove the finger which gave the preceding note. Here, then, the C on the fourth string is stopped by the first finger instead of the second, as in the previous position. [Ex. **14**.]

Playing the same scale in the *Fourth Position*, and beginning on the note D, this will be stopped by the first instead of the second finger, as before. [Ex. **15**.]

In fingering the four strings correctly, the left hand must now be more elevated over the edge of the belly and the elbow carried further under the violin, so that the fingers may be able to reach the G string easily. Hold the instrument firmly with the chin. According to the size of the player's hand, so does the thumb leave the neck of the fiddle and cling to the rim of the belly close to the fingerboard, and in returning to a lower position the thumb always leads the way.

By slipping the hand up so that the first finger takes the place lately occupied by the second, the fingering changes to that of the *Fifth Position*. [Ex. **16**.]

In the *Sixth Position*, instead of the index finger representing the first E on the fourth string, the hand moves up and the first finger presses down F. [Ex. **17**.]

The top note on the first string is now G (fourth ledger line above staff). This is the limit within which second violin parts in orchestral music are written.

The highest recognised position in violin playing is the *Seventh*, the top note of which is A, and the three semitones above—namely. A♯, B and C—indicate the limit at which stopped notes may be played on the fingerboard, In this position, then, the first finger gives G on the fourth string, exactly an octave above the pitch of the open note. [Ex. **18**.]

High Notes. Save that the higher the hand goes up the closer the intervals become, there should be, with practice, little more difficulty in fingering the seventh than the second position. The reason that the higher shifts are generally regarded as presenting great difficulty is chiefly owing to want of familiarity with them, most violin music being written in the lower register. But the mere fact of the intervals being close together in the high positions, and a high note, if played out of

Ex. 21.

tune, being more noticeable than a low one, should stimulate the student to distribute his technical exercises at least equally over the seven positions. For the violinist to confine his attention to the first and third positions puts him on a level with the piano strummer, who is familiar only with the three centre octaves of the keyboard, and neglects all the other notes.

It is not so much the difficulty in fingering as the trouble of reading many ledger lines that causes the student to hold aloof from trying to master the top shifts. It is only by practice that great violinists have learnt to read with equal facility notes high up above the staff as those on it. Considering that the violoncello player must make himself conversant with the bass and tenor clefs as well as the treble staff, the task of the violinist is, comparatively, far less difficult. All that has to be done is for the pupil to proceed systematically in his daily practice, and gradually he will find himself becoming as familiar with the top of the compass as the bottom.

tion, unless he realises that great players have found it enhances the tone of certain melodies, which, like those in the key of B major, lie naturally within the half position. Like many other perplexities in violin playing, it is not so impracticable as it appears to be. The only difficulty to overcome is to place the second finger correctly. [Ex. **19**.]

Whereas, in the second position, the low B is stopped by the first finger, and in the first position by the second finger, the hand being shifted nearer the nut, the same B is negotiated by the third finger. So the second finger takes the A two semitones above the open note of the G on the fourth string, the E two semitones above the open D of the third string, the B on the A string, and the G♭ or F♯ two semitones above the open E of the first string.

Interchanging Positions. Having learnt to play in each position as well as the half shift without moving the hand from its respective situation, the student should study to

Ex. 22.

Ex. 23.

Half Position. In addition to the seven positions described, there is what the Italians call the "Mezza Manica," literally the "half neck," or shift. This is not midway between the first and second positions, as might be surmised. That would make it a position and a half. Instead, the fingers stop the notes one degree *lower* than the first position. The hand must therefore be kept quite close to the nut of the fingerboard. Let the first finger touch the E string peg. In music intended for the half position, a low F✱ is not infrequently written. The student observing it for the first time may think that it is below the compass of the violin, and that he will have to let down his fourth string slightly to play it.

He may save himself the trouble. If he adds mentally two semitones to F♮, he will understand that the sound required is only the open G. After familiarising himself with the fingering of the seven positions, the self-instructor may regard the half position as an unnecessary complica-

apply the knowledge he has acquired by transferring his fingers from one position to another, so that, no matter on what part of the fingerboard a scale or passage may lie, he may be able to execute the whole of a phrase in the most telling manner, with the least possible temporary hand movement [Ex. **19a**]. If in the same group a fresh position has to be taken, and the finger, without leaving the string, glides from one interval to another, the art is so to make the movement as not to develop an ugly whine or wail. The matter of taking the different intervals is termed *portamento*.

Portamento. Even as, in singing, this implies a "lifting" of the voice from one note to another, and the "bearing and behaviour" meanwhile of the artist, so must the left hand of the violinist be taught by practice to move—in more senses than one—in a "correct" way, so that there may be no undue slipping about of the hand on the neck. This is not only ineffective, but undignified. The object in changing

from one position to another is not to whine up and down the strings, but to finger with ease passages which otherwise might be difficult or impossible in the normal position. To enable the portamento to be done effectively, the left hand should be occupied solely in stopping the notes. The instrument, therefore, at such times will be held with extra firmness between the chin and collarbone. [Ex. 20.]

Extensions. In accordance with the way the fingers are stretched to stop the notes, so is the extension known as "superior" or "inferior." The tendency is to play hopelessly wrong notes when first essaying various changes of position. This should be carefully checked by the student transposing a high passage an octave lower. After playing it in the first position, so as to get the sounds well into his head, he can then try it in the higher shifts, together with the portamento effect desired. By continuing to use a uniform style of bowing, linking together with one stroke those notes which are slurred, the student will be able to concentrate his attention on the correct fingering. Whilst he plays as smoothly as possible, his first aim will be to get true intonation, so that whenever an E, A, D, or G occurs, he should test it by the octave of an open string.

"Sopra la 4ta." A knowledge of the higher positions having been gained, extensive skips from low to high notes, and *vice versa*, will become easy if carefully practised, the student always avoiding that whining effect which too much gliding gives. On account of the special character of tone which the lowest string possesses, several bars will sometimes be found marked "sopra la 4ta," which, in English, reads "upon the fourth" string. In that case, the whole of the passage, no matter how high it goes, must be played on the G, and the knowledge the student has of the higher positions will enable him to do justice to the intentions of the composer.

Four-string Chords. So far, we have confined our attention to the fingering of single notes. Agreeably with the human voice, but unlike the piano or organ, the violin is an instrument naturally adapted for monodic performance. Yet it excels the voice in that it can produce several sounds simultaneously from its four strings, certain of the notes being further apart than could be stretched with one hand by any pianist. Four-string chords are usually only possible with short notes. Whisk the hair quickly from the two lower to the two upper strings. Although the bow leaves the two lower strings, the vibrations of the latter continue, and so form the chord. Try Exercise 21 by drawing the bow with a semicircular motion firmly at the nut across all the four strings.

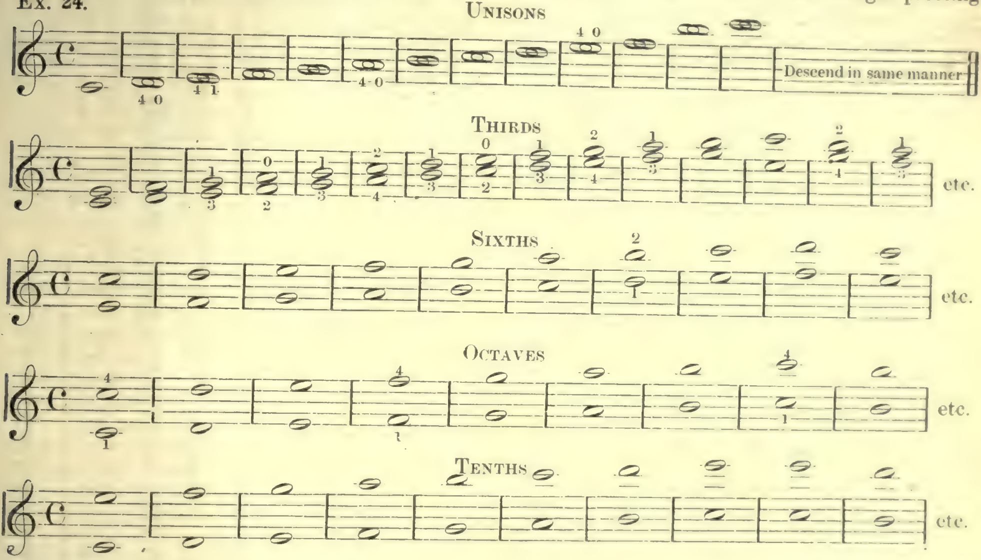
Double Stopping. When two strings are bowed together with either finger pressing them, the effect is known as double stopping. This term also includes the playing of three or four notes at the same time. If a descending passage is begun on the E and A strings, the upper part cannot continue lower than the open sound of the D string, since two notes cannot be emitted from the single G string. Nevertheless, thoughtless composers have been known to write such an impossibility. Now take the double stopping systematically. [Ex. 22.]

After combining the open string simultaneously with groups of four notes, try Exercise 23.

Get well under control ascending and descending unisons, thirds, sixths, octaves, and tenths. [Ex. 24.]

By changing the order and duration of these double notes, an inexhaustible series of studies can be made. The life of no violinist has yet sufficed for him to learn everything that can be acquired from this marvellous instrument.

Ex. 24.



Continued

Group 10 **ELECTRICITY** 17 Continued from page 2248	# ARC LAMPS **The Electric Arc. Distribution of Light. Inverted, Enclosed, and Alternating Current Arcs. Arc Lamp Mechanisms**

By Professor SILVANUS P. THOMPSON

ONE of the first fruits of Volta's invention of the pile for generating continuous currents, in 1800, was Davy's discovery of the arc. He experimented on the spark that is produced between the ends of two wires through which the current from a pile, or battery of cells, is flowing when the wires are suddenly parted from one another, and observed that the spark produced between two pieces of boxwood charcoal is brighter than that between the tips of two metallic wires. Using more powerful batteries, he found that if the tips of the two pieces of charcoal are not withdrawn too far apart the spark becomes a persistent flame. In his experiments the two pieces of charcoal were held horizontally, and the flame so produced formed an arch between them, being drawn upward by the ascending air. This electric flame he called *the arc.* If produced thus with wood charcoal, the material disintegrates into the flame, which becomes itself extremely brilliant, though unsteady. Using a battery of several hundred cells, he was able to draw out the arc to the length of several inches [**170**].

Forty years later, Foucault substituted for wood charcoal pencils of hard graphitic carbon of the kind which is found encrusting gas retorts, and which is used in making carbon plates for batteries. If this substance be ground up to powder, purified, mixed with a small quantity of tar to bind it together, compressed by hydraulic pressure into rods, and baked in closed crucibles at a bright red heat, the resulting pencils are hard and graphitic, and conduct well. A rod 0·5 in. in diameter has a resistance of about $\frac{1}{10}$ ohm per foot. Such pencils, of different sizes according to the current to be carried, are used in arc lamps.

Arcs of Various Kinds. In modern arc lamps the carbons are seldom disposed horizontally, as in Davy's arc, though this arrangement is still used in some forms of searchlights at sea. The several arrangements in general use are:

Vertical arcs.
Inverted arcs.
Enclosed arcs.
Alternate-current arcs.
Flame arcs.

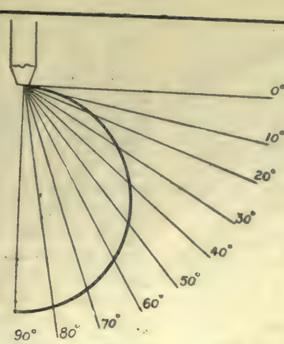
By far the most usual of these is the vertical arc supplied with a continuous current. The carbons stand vertically over one another, separated by about $\frac{1}{8}$ in., and the current flows downwards, the positive carbon being above and the negative carbon below. It will be convenient to state the properties of this kind of arc first before discussing the other forms.

Properties of the Arc. Suppose a carbon rod 0·7 in. in diameter to be held vertically in a convenient holder so that it can be moved up and down and clamped at any point. Below it let there be placed in a line with it another slightly thinner carbon rod, say 0·475 in. in diameter. Let the upper one be joined to the positive main, and the lower one to the negative main. The voltage of these mains should be not less than 60 nor more than 100 volts, and a set of adjustable resistance wires should be inserted in the circuit to regulate the amount of current. Suppose, now, the tips of the two carbons be made slowly to approach toward one another, it will be found that nothing happens unless they are actually brought into contact. Even when the air gap between them is no thicker than a visiting card, the arc will not start of itself. To *strike* the arc, the carbons must be brought for an instant into actual contact, and then drawn back till they are separated by about $\frac{1}{8}$ in. At once the light flashes out as the arc forms itself, resembling the picture in **171**.

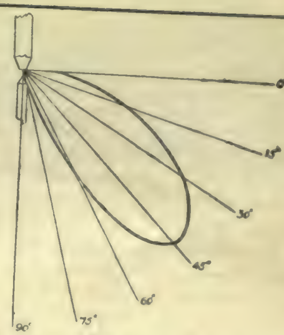
On examining the arc through dark glasses —to prevent injury to the eyes—or by projecting an image of it on the wall with a lens, several points will be noticed. The flame itself gives almost no light, and consists of an inner core of pale violet colour, surrounded by an outer envelope of a greener tint. A dazzling white light is given out from the bottom end of the upper carbon, and a less amount from the top end of the lower carbon. In fact, the source of the light is the surfaces of the white-hot tips of the carbon rods. These gradually burn away and assume the shapes shown in the figure. The positive carbon assumes the form of a cone truncated at the bottom. The conical part glows red-hot, but the bottom surface, which is hollowed to a sort of *crater*, glows white-hot. The negative carbon is also coned, and acquires a projecting peak, the tip of which is white-hot. Nearly all the light comes from the positive *crater*, and therefore the main light of the arc is thrown downwards. The temperature of the crater is about 3500° C., that of the negative peak about 2700° C.

Instability of the Arc. The arc, being a flame, is liable to be blown aside by currents of air, hence it must be protected by a glass globe. It can also be deflected on one side by a magnet, since it is a flexible conductor of the current. If the upper carbon be slowly drawn upward the arc lengthens and becomes unsteady. If the length from tip to tip exceeds about $\frac{1}{2}$ in. the arc goes out, and does not relight itself unless the tips are again brought into momentary contact to re-strike the arc.

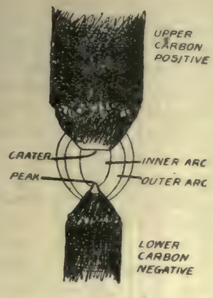
170. DAVY'S ARC



172. DISTRIBUTION OF LIGHT FROM CRATER

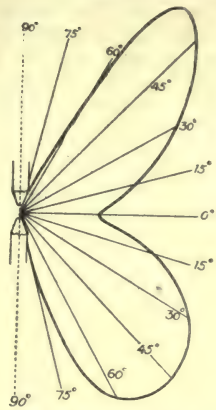


173. DISTRIBUTION OF LIGHT FROM C.C. ARC

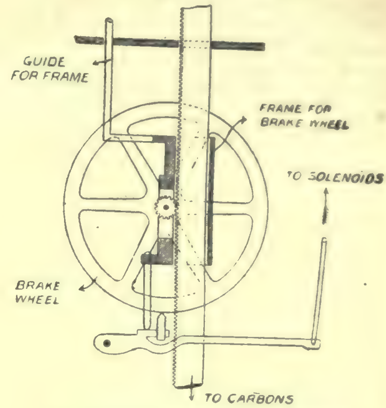


171. CONTINUOUS CURRENT ARC

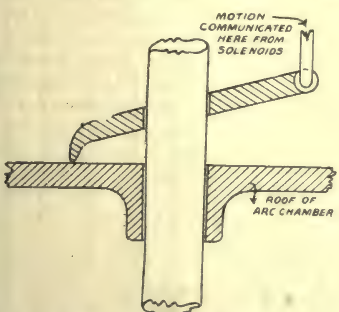
174. SKETCH OF ENCLOSED ARC



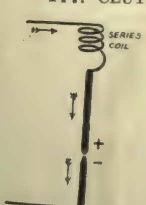
175. DISTRIBUTION OF LIGHT FROM A.C. ARC



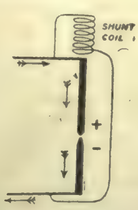
176. BRAKE-WHEEL MECHANISM



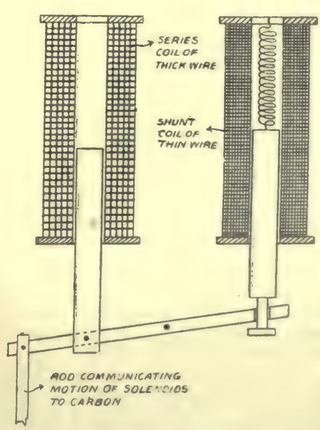
177. CLUTCH MECHANISM



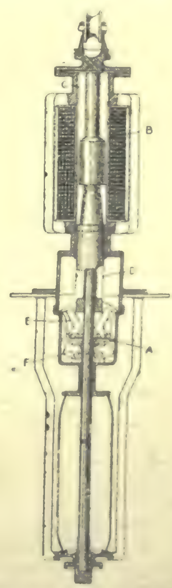
178. DIAGRAM OF CONTROL OF ARC BY SERIES E.M.



179. DIAGRAM OF CONTROL OF ARC BY SHUNT E.M.



180. SEE-SAW MECHANISM



181. JOHNSON & PHILLIPS' LAMP

DIAGRAMS ILLUSTRATING PRINCIPLES AND MECHANISMS OF ARC LAMPS

If higher voltages are used, the arc can be drawn out longer, but in this there is little advantage. If the carbons are brought too near together, without touching, the arc hisses and becomes unsteady, while an excrescence of carbon, called a mushroom, forms on the negative peak. The hissing is due to air getting to the crater surface. A steady arc cannot be formed unless the electromotive force exceeds 40 volts or so.

Feeding the Arc. If the carbons are held fixed in a constant position they gradually consume away by combustion, the positive one consuming about twice as fast as the negative one. Hence the arc itself gradually lengthens and becomes unstable, and will go out unless means are taken to move the carbons nearer together and so bring back the arc to its proper length. In arc lamps a mechanism is provided to move the carbons little by little nearer together as they burn away—in other words, to *feed* the carbons forward into the arc. When the top carbons used are twice the section of the bottom ones, each will burn away at a rate of about two-thirds of an inch in the hour. To make the arc more steady the top carbons are often made with a central hole filled from top to bottom with a *core* of softer carbon.

Distribution of Light from the Arc. The size of the crater that emits the light is nearly proportional to the number of amperes flowing through the arc. With a 10-ampere current the crater has about $\frac{1}{50}$ of a square inch of surface, and therefore a diameter of about 0·16 in. A circle of white-hot carbon of this size would emit in the direction normal to its surface a light about equal to 2,000 candles. But in oblique directions the light would be less in proportion to the cosines of the angles; and moreover in the actual case the negative carbon gets in the way and casts a shadow downwards. Hence the light is greatest in an oblique direction and from an arc of this size is less than 2,000 candles in the maximum direction, and is indeed less than 800 candles if the average value in all directions is reckoned. If the negative carbon did not get in the way the light from a crater of this size would have the following values at the several angles, reckoned below horizontal:

Angle	0°	15°	30°	45°	60°	75°	90°
Light	0	520	1000	1414	1730	1930	2000

These amounts are exhibited graphically in **172**. But as the negative carbon eclipses a lot of the light, and as its tip throws a little light out sideways, the actual distribution would be more nearly represented by the values:

Angle	0°	15°	30°	45°	60°	75°	90°
Light	220	700	1250	1420	720	0	0

These values are given graphically in **173**. The amount cut off by the negative carbon would be greater if the arc had been shorter. The circle of shadow cast by the negative carbon can be observed on the opal globes of ordinary arc lamps.

Inverted Arcs. For lighting picture galleries, drawing offices, and workshops, it is often preferred that the light should be thrown upwards on to a whitewashed ceiling rather than downwards; inverted arcs are then used, with a thick positive carbon at the bottom and a thinner negative one at the top. The advantage is that with the light thus diffusely reflected from the whitened surfaces no shadows are cast.

Enclosed Arcs. To reduce the consumption of carbon, which results from the access of the air, and to lessen the cost of maintenance and attention, it has become the fashion to surround the arc by a globe entirely closed at the bottom and nearly closed at the upper part. When the lamp is first lighted the oxygen present in the air of the globe is quickly consumed, and after that there is left in the globe only an inert atmosphere, in which the carbons will last six or seven times longer than they would in an open globe. The enclosing vessel must not be absolutely air-tight, or it will blacken. In the enclosed arc the carbons assume a different shape, with neither crater nor peak, but nearly flat at the ends [**174**]. To get a good distribution of light the arc must be drawn out longer, and as the greater length of the gaseous column will offer a greater resistance, higher voltages—from 70 to 80 volts across the arc—are employed. Some enclosed lamps have double globes, a small inner globe and a larger outer. This is, however, unnecessary.

Alternate Current Arcs. When an alternating current is used, each of the tips emits light; for since the current flows first up, then down, in rapid alternation, each of the tips becomes alternately positive, and each acquires a small crater. As a result, the light is thrown partly obliquely upward and partly obliquely downward, the distribution being as indicated in **175**. It is, therefore, usual to surround the upper carbon a little above its tip with a reflector to throw downwards the upper part of the light. The alternating arc can be worked with a voltage of from 33 to 45 volts. If enclosed, to make the consumption of carbon slower the voltage can be increased.

Arc Lamps. Hitherto we have spoken of the electric arc pure and simple; we now come to see how it is arranged for practical lighting purposes. The mechanism which makes the burning of the arc automatic when once the current has been switched on must perform the following functions: (1) bring the carbons together when no current is flowing; (2) strike the arc—*i.e.*, move the carbons a suitable distance apart—when the current is switched on; and (3) feed forward the carbons as they burn away, so that a constant length of arc is maintained. Various other things are required in special cases, but the above are fundamental. We may deal with them in order. (1) When the current discontinues to flow, the usual action is that all regulating mechanism becomes inert, loses any grip of the carbons which has been necessary to regulate them, and the top carbon by virtue of its own weight drops into contact with the bottom carbon. (2) Many mechanical contrivances have been invented for striking the arc, but the two most important are the clutch

and the brake-wheel mechanism. In present-day lamps the same mechanism is arranged to do both the striking and the feeding, therefore these two operations may be considered together.

Mechanical Part of the Arc Lamp Mechanism. For our present purpose it will suffice to give typical examples illustrating the main forms which are in use, and finally to describe one lamp in detail, so that the reader may be able to combine any of the parts separately described into a completed form.

Brake-wheel Mechanism. The weight of the descending upper carbon and its holder drives a wheel, against the rim of which a brake can be applied. This brake is operated by a lever that is automatically raised when the current is strong, and lowered when the current is weak. Suppose the carbons to be resting one against the end of the other. Then when the current is switched on, as the resistance is small, there will be a strong current which causes the lever to rise, gripping the brake against the wheel and turning or raising it, and so lifting the upper carbon and striking the arc. After a few minutes, when the tips have burned away a little, the arc offers more resistance, and the current therefore decreases. Hence the regulating lever falls, and by releasing the wheel permits the top carbon to descend a little, when the increase of current again checks the movement. Fig. **176** shows a brake-wheel mechanism.

Clutch Mechanism. The clutch may be arranged to act either directly upon the upper carbon rod, or upon a metal rod that holds the upper carbon. The action is similar to that of the brake-wheel, the clutch nipping against the carbon rod and raising it a little when the regulating lever is raised, and releasing the carbon rod when the regulating lever falls. The action will be evident from inspection of **177**.

Electrical Part of Controlling Mechanism. Arc lamps are run on the series, parallel, and series-parallel systems of supply [see page 2245]. The problem in the design of a mechanism is to arrange that the energy given to each lamp is the same, so that equal amounts of light are emitted. Obviously, in the series system, as the *same* current must flow through each lamp, we must arrange that the voltage is equally distributed; in the parallel system it is the current in each lamp which has to be regulated, for the voltage is constant; and in the series-parallel arrangement, where, say, sets of three lamps are run off 250-volt mains, we have to see both that each set takes the proper current, and that the voltage is divided equally among the three lamps. These various arrangements are made by varying the windings on the coils. If we wish to regulate the current we send the actual current which passes through the arc round a coil of thick wire [**178**], and when the current is of the right strength we arrange that the arc is opened to the requisite amount.

If it be the voltage that must be regulated, we use a coil of thin wire and connect it across the arc, and when the arc has the correct voltage, the current which flows around this *shunt* coil [**179**] is just sufficient to maintain the carbons the proper distance apart.

If we wish to regulate both voltage and current two coils are used. These may, of course, be wound upon the same core, but as it is desirable to have some weight (or some *inertia*) in the mechanism, the arrangement shown in **180** is often adopted, wherein a see-saw lever carrying an iron plunger at each end is acted upon by two coils, one of thick wire in series with the arc, the other of fine wire placed in shunt.

Example of an Arc Lamp. The example given in **181** is a very simple and effective construction due to Messrs. Johnson & Phillips. A coil in the upper part of the lamp (shown in section) draws up magnetically an iron plunger of conical form, and with it raises a series of L-shaped nipping-levers which grip the upper carbon rod and raise it. The pattern shown is that used with an enclosed arc, there being a small enclosing globe, into which the upper carbon enters, as well as a larger surrounding lantern or outer globe.

Continued

Group 7 CLERKSHIP 17	GROSS PROFIT
Continued from page 2272	Accounts and Nominal Accounts. Prime Costing. The Quantitative Method. Testing the Results of Stocktaking. Checking Fraud

GROSS PROFIT

By A. J. WINDUS

THE most troublesome item in the goods account is that relating to stock. The reason exists in the dual nature of the account itself.

Accounts and Nominal Accounts. In the first place it belongs to the class of *real* accounts, which also embraces cash, bills payable, bills receivable, fixtures and fittings, and every species of property employed in or associated with an undertaking. But upon reflection we must admit that the goods account also belongs, in part at least, to the class of *nominal* or temporary accounts. Such accounts exist in name only, they are, in fact, sub-accounts, which for the sake of convenience are kept separate until merged by transfer in some account of superior degree. To this class belong the sub-accounts which jointly constitute the profit and loss account, as rent, rates and taxes, salaries and wages, trade expenses, discounts, and all sub-accounts of gains, losses, and expenses.

The goods account is related to this group through the sales. Every profitable sale is effected at a price which represents cost *plus* profit. The theory is that these accumulated profits are periodically transferred to profit and loss account. The adjustment by transfer having been made, it is possible by deducting the total credit on goods account from the total debit to arrive at the cost of the unsold goods or stock on hand. Whatever its amount, it would first be placed on the credit side of goods account to make it balance, and would then be brought down on the opposite, or debit, side as the first item in the new account, the old account being ruled off in the ordinary way.

Stock in Hand. In practice, however, the value of the stock on hand is ascertained by actual survey of the unsold goods, in the same way as the amount of cash on hand is found by counting the cash in the till. But while there should be an exact correspondence between the amount of cash in the till and the cash balance disclosed by the office cash account, there is ordinarily no such correspondence between the amount of goods on hand and the balance of goods account in the ledger. Theoretically, there is no reason why after allowing for profit or loss on goods sold, and perhaps for reduced value of goods unsold, the balance shown on the goods account should not coincide with the value of the stock on hand as ascertained by survey—*i.e.*, stocktaking. We may illustrate this by an example. At the end of the first year's trading, Mr. Andrew Crawford learned as the result of stocktaking that he had on hand 489 size A and

Dr. Goods a/c (No. 3)

1902 Dec 31	To Purchases							
	5732 "Triumph" A @ 8/6		2436	2	.			
	1476 do B @ 11/4		836	8	.			
						3272	10	
	To Rets. from customers							
	217 A stoves @ 10/-		108	10	.			
	140 B do @ 13/4		93	6	8			
						201	16	8
					.	3474	6	8
	To Gross Profit transfd to P & L a/c					519		6
					£	3993	7	2
1903 Jan 1	To Stock	Bd.				290	11	2
	489 A @ 8/6		207	16	6			
	146 B @ 11/4		82	14	8			
		£	290	11	2			

Contra Cr.

1902 Dec 31	By Sales							
	5432 A @ 10/-		2716					
	1419 B @ 13/4		946					
						3662	.	.
	By Rets. to factory							
	28 A @ 8/6		11	18	.			
	51 B @ 11/4		28	18	.			
						40	16	.
	By Stock (at cost)							
	489 A @ 8/6		207	16	6			
	146 B @ 11/4		82	14	8			
						290	11	2
					£	3993	7	2

146 size B "Triumph" stoves. These he valued at cost, and on this basis the stock was worth £290 11s. 2d., *viz:*

		£	s.	d
489 A stoves @	8s. 6d. =	207	16	6
146 B stoves @	11s. 4d. =	82	14	8
	Total	290	11	2

The total agrees with the balance brought down on goods account No. 1 and on goods account No. 2, after the accumulated profits on sales have been transferred to P. and L. account. But those accounts are not sufficient in themselves to explain the coincidence. Attention is therefore directed to goods account No. 3 [see preceding page], wherein the facts already dealt with in the two preceding accounts are treated quantitatively.

By a slight rearrangement of the figures we are able to confirm the stocktaking quantities as follows:

A.			B.	
5732		No. of Stoves purchased	1476	
28		Less returned to factory	51	
	5704	Net purchases		1425
5432		No. of stoves sold	1419	
217		Less returned by customers	140	
	5215	Net Sales		1279
	489	No. of stoves in stock, 31 Dec., 1902		146

Gross Profit. The selling prices of A and B stoves are 10s. and 13s. 4d. as compared with cost prices 8s. 6d. and 11s. 4d. respectively. Hence arises the gross profit of £519 0s. 6d. It follows that if cost and selling prices were identical the item "gross profit" would disappear from the goods account altogether, although the balance representing stock on hand brought down would remain unaltered. Thus, if in goods account No. 3 the cost prices were adopted for the whole of the calculations on both sides of the account we should obtain this result:

proceeds quite independently of the goods account in the ledger. Nevertheless, the results of stocktaking must be known and incorporated in the goods account ere we can decide the question as to whether a trading profit has been made.

Therefore, the first step towards closing the goods account is to take stock. The second step is to credit by the value of the stock on hand the account about to be closed, at the same time opening a new account and debiting it with the value of the stock transferred thereto. If, as in example No. 3a, the two sides of the old account then agree, we are forced to the conclusion that no profit has been made. If, as in the three preceding accounts the total of the credits exceeds the total of the debits, the difference or margin is gross profit. To dispose of this difference a transfer entry should be put through the journal and posted, debiting goods account and crediting profit and loss account [see rule for transfers, page 1569].

In a goods account constructed on the lines of example No. 3 before us, we are able to utilise the recorded quantities and prices in verifying the accuracy of the gross profit as stated. We have seen that profits are derived solely from the sales, but that they are liable to diminution by the amount of any shrinkage in value of the unsold goods. In the present case there is no shrinkage, and the calculation to be performed becomes a simple matter. Allowing for returns from customers, 5 215 A stoves were sold at 10s. each, being an advance over cost of 1s. 6d. per stove; therefore, the total profit on A stoves must be 1s. 6d. × 5,215 = £391 2s. 6d. Again, 1,279 B stoves were sold at 13s. 4d. each, or an advance over cost of 2s. per stove. The total profit on B stoves is, therefore, 2s. × 1,279 = £127 18s. 0d. If this amount be added to the profit of £391 2s. 6d. on A stoves, we shall obtain a combined profit of £519 0s. 6d., as shown.

The Quantitative Method. Quantitative accounts of raw material, labour, finished

Dr. Goods a/c (No. 3a.)

	To Purchases (per No 3 a/c)					3272	10	—
	" Returns inwards							
	217 @ 8/6		92	4	6			
	140 @ 11/4		79	6	8	171	11	2
						£3444	1	2
	To Stock	b/d				290	11	2

Contra Cr.

	By Sales							
	5432 @ 8/6		2308	12				
	1419 @ 11/4		804	2		3112	14	
	" Returns outwards (per No 3 a/c)					40	16	
	" Stock (per No 3a/c)					290	11	2
						£3444	1	2

Several important facts emerge from a comparison of account No. 3 with account No. 3a. First we notice that in spite of the evanishment of gross profit from the latter the amount of stock on hand at end of 1902 has undergone no change. This constancy emphasises the fact that the value of the unsold goods at stocktaking is not necessarily the difference between the two sides of the goods account, although it happens to be so in account No. 3a. Stocktaking, indeed,

products, and expenses of production are essential to every genuine system of cost accounts. Prime costing, as it is termed, is a latter-day development of accountancy, but more especially of the analytic method to which reference has been made. It is resorted to chiefly by the contractor and the manufacturer; by the contractor because estimates for work proposed to be undertaken should be founded upon data supplied by the prime cost accounts of executed contracts;

by the manufacturer because thereby an efficient control over every department of manufacturing can be maintained.

Outside these two classes of business men, the quantitative method of account-keeping meets with small favour, and the reason is not far to seek. It is a good business maxim that the result aimed at should be commensurate with the effort put forth, and it is generally felt that the labour of keeping continuous and classified records of the quantities of stock bought and sold from day to day is too high a price to pay for the consequent benefit of being able to check the quantities of stock on hand as ascertained by actual survey with the balances appearing in the stock register.

Testing Stocktaking Results. Accordingly, business men have adopted a shorter method of testing the results of stocktaking which, although not absolute, answers all practical purposes. The method referred to consists in ascertaining whether the *rate* of gross profit earned is a proper one, having regard to all the circumstances. If the rate is normal, or varies but slightly from the normal, and the prices, extensions, and summations of the stock book have been carefully verified, then the amount of stock on hand is assumed to be correctly stated; but if the rate is abnormal an investigation of the goods account, including the item of stock on hand at the end of the period, will have to be made.

For instance, in goods account No. 2, quantities are not registered, but values only. Taking the net sales as £3,460 3s. 4d. (£3,662—£201 16s. 8d.), the gross profit as £519 0s. 6d., and applying the rule for percentages, the profit works out at a rate of 15 per cent. on the sales (£519·025 × 100 ÷ £3,460·16 = 15). Mr. Crawford is satisfied from this showing that the value of the stock is

In a great many businesses, the stock comprises a variety of articles of trade, and the prices are legion. Here, it would be folly attempting to prove the value of the stock by making calculations based upon the difference between cost and selling prices. The simplest plan is to adopt an *ideal* rate of gross profit for each business coming under this category, and to treat any marked deviation therefrom in the *actual* rate as a warning not to pass the item of stock in the goods a/c without further inquiry.

To determine the ideal profit rate which should obtain in a given case, it is advisable to fall back upon the experience of former years, or of other people engaged in the same trade. While it is true of trade generally that different rates of gross profit prevail where trades are dissimilar, it is, with certain reservations, no less true that in any particular trade there exists a recognised standard of gross profit to which the majority of the traders endeavour to conform. Industrial competition—that great leveller of prices—is mainly responsible for this tendency of gross profit rates to become uniform; but we merely note the fact and pass on to illustrate the mode of applying the ideal or standard rate of gross profit in the detection of error.

Suppose that the goods account in Mr. Crawford's ledger had been kept in abstract form as shown in goods account No. 2, but that while the figures for purchases, sales and returns were the same as given in our example, the amount of "stock on hand (at cost)" differed, being recorded as £248 1s. 2d. instead of £290 11s. 2d. We should expect to find this reduction in the ledger value of the stock reflected in the decrease of gross profit shown, and this is precisely what happens [see account below].

Taking the *net* sales as £3,460 3s. 4d. and the gross profit at £476 10s. 6d., Mr. Crawford

Dr.	Goods a/c (No. 2a)						Contra				Cr.
1902 Dec 31	To Sundries (purch.)		3272	10		1902 Dec 31	By Sundries (sales)		3662		
	" Do. (returns inwards)		201	16	8		" Do. (returns outwards)		40	16	
	" Balance, being Gross Profit tsfd. to Profit & Loss a/c		476	10	6		" Stock on hand (at cost)	c/d	248	1	2
			£3950	17	2				£3950	17	2
1903 Jan 1	To Stock	b/d	248	1	2						

correctly stated, because his selling prices were calculated on a basis of 15 per cent. "on returns."

Thus, if 1s. 6d., which is 15 per cent. on 10s., be deducted from the selling price of A stoves, we shall arrive at the cost price, 8s. 6d.; so also, if 2s., or 15 per cent. on 13s. 4d., be deducted from the selling price of B stoves, the cost price, 11s. 4d. will stand revealed.

would have discovered that the rate of profit worked out at slightly under 13·8 per cent. This result being clearly inconsistent with the fact of a 15 per cent. margin of profit between cost and selling prices he would feel convinced that something was wrong. In the case we are supposing, a careful recount of the stoves in stock revealed the fact that a mistake had

been made in counting 389 A stoves instead of 489. The error produced a depression of £42 10s. 0d.—representing the cost of 100 A stoves at 8s. 6d. each—in the *book value* of the stock. When the necessary adjustment had been made, the amount of stock would appear as £290 11s. 2d., the gross profit would be correspondingly increased to £519 0s. 6d., and the rate of profit would work out at 15 per cent. as required.

If, when tried by the touchstone of the standard rate of gross profit, an actual rate appear erroneous, we may be sure that, whatever the source of the discrepancy, it is of sufficient importance to warrant an attempt to locate it. Sometimes a discrepancy can be shown to be the result of legitimate causes, and at other times the most determined efforts to unravel the mystery may prove unavailing.

Frequently, however, the knowledge that the actual rate of gross profit is false has led to the discovery of the fraud or error which it prognosticates.

Falsification of Profit. For the trained auditor the subject of Fraud or Wilful Error in its manifold aspects as relating to accounts possesses a peculiar interest. We will select three examples of the falsification of profit.

1. The managing director of a limited liability company holds certain shares in the company which he desires to sell at the best price obtainable. It is, therefore, to his interest that the market value of the shares should rise; and a powerful lever for forcing the price of shares upwards is the payment of satisfactory dividends to the shareholders. By law, however, dividends must be paid out of profits only, and, other things being equal, the sum available for dividend distribution among the shareholders will vary directly with the amount of *net* profit, and this in turn will be profoundly affected by the amount of gross profit made. In order to inflate the amount of gross profit, the managing director caused certain invoices for goods arriving immediately prior to stocktaking to be "dated forward"—*i.e.*, post-dated—and omitted such invoices from the debit side of goods account, despite the fact that the goods to which they referred were included with the rest of the unsold goods in the item "stock on hand" on the opposite side of the goods account. Consequently, the gross profit balance shown on goods account was largely fictitious; but everything seemed to be quite in order, the stock book having been examined, and the usual inquiry as to whether all invoices had been passed through having been answered in the affirmative. So it is at least doubtful whether, failing the application of the gross profit percentage test, the deception would have been laid bare in time to prevent the payment of a dividend which had not been earned.

2. A boot and shoe dealer wishing to conceal from the Income Tax authorities a portion of his trading profits took stock, and in the process marked down the cost prices of all unsold goods by 25 per cent. Thus stock on hand was credited in the goods or trading account at a reduced amount, the gross profit balance transferred to profit and loss account was lessened thereby, and the final balance of net profit transferred from profit and loss account to capital account was likewise diminished.

Under certain conditions such a reduction would be fully justified. Thus, if the cost prices at the time of stocktaking had actually sunk to the level here indicated, then the unsold goods, even though they had cost more, would not be *worth* more to the business than new goods of the same description—especially in view of the fact that when wholesale prices are declining retail prices display a sympathetic downward tendency. Accordingly, the unsold goods should not be valued at more than the totaal mount for which they could, if necessary, be replaced immediately upon the conclusion of stocktaking.

It may occur to some that if, as compared with the actual purchase prices, the market prices at stocktaking of unsold goods had *risen* the trader would have been entitled to value his stock at the higher level of prices, but this idea is fallacious. The trader who schedules his unsold goods at higher prices than he paid for them is simply "anticipating profits"—a dangerous policy, because until goods have been sold no profit has been earned. To show a fictitious gross profit in the goods or trading account by overstating the value of the stock is to court disaster. Hence the excellent rule that goods are to be priced out in the stock book at cost or market price, *whichever is lower.*

The fraud committed by the boot and shoe dealer in the case before us consisted in depressing the value of his stock below cost at a time when, owing to the advance in the price of leather, and the consequent rise in wholesale prices, his unsold goods had become more valuable than when he bought them. Stock which was worth at cost, say, £1,600 was brought into the goods account at £1,200, and the net profit, which in reality was £500, appeared in the profit and loss account as £100 only.

3. A firm of merchants were in the habit of taking press copies in a tissue copy book of all invoices despatched. These copy invoices were not posted direct to the sales ledger, but were entered in abstract form in a sales journal, and from thence the amounts were posted to the respective sales ledger accounts. The bookkeeper, who was also the cashier, hit upon the expedient of omitting to pass certain invoices through the sales journal, and consequently they did not appear in the sales ledger. In due course the amounts of these omitted invoices were received from the debtors and came to the hands of the cashier, who retained them for his own use. Since he was careful not to record these amounts in the cash book, there was no discrepancy between the cash receipts and the bank lodgments, which might have aroused suspicion, and in the result the profits of the year during which these practices prevailed showed a serious falling off.

Continued

Group 11
CIVIL ENGINEERING
17
ROADS
continued from page 2327

NEW STREETS & FOOTPATHS

Requirements and Cost. Dedication as Public Highways. Setting out Footpaths. Costs of Construction and Maintenance

By A. TAYLOR ALLEN

A *street* defined by the Public Health Act, 1875, and the Private Street Works Act, 1892, is a highway, bridge (not being a county bridge), road, lane, footway, square, court, alley, or passage, whether a thoroughfare or not.

Highways under the Highway Act, 1835, mean all roads, carriageways, cartways, horseways, bridleways, footways, causeways, churchways, and pavements.

Requirements of Local Authorities. Section 150 of the Public Health Act, 1875, enacts that where any street within any urban district (not being a highway repairable by the inhabitants at large), or the carriageway, footway, or any other part of such street is not sewered, levelled, paved, metalled, flagged, channelled, and made good, or is not lighted to the satisfaction of the urban authority, such authority may, by notice addressed to the respective owners or occupiers of the premises fronting, adjoining, or abutting on such parts thereof as may require to be sewered, levelled, paved, metalled, flagged, or channelled, or be lighted, require them to sewer, level, pave, metal, flag, channel, or make good, or to provide such proper means for lighting the same within a time to be specified in such notice.

If such notice be not complied with, the urban authority may, if they think fit, execute the works mentioned or referred to therein, and may recover in a summary manner the expenses incurred by them in so doing from the owners in default, according to the frontage of their respective premises, and in such proportion as is settled by the engineer of the urban authority.

Powers of Urban Authorities. An urban authority may adopt the Private Street Works Act, 1892, in place of sections 150, 151, and 152, of the Act of 1875. Under this Act, questions between the owners and the authority as to whether the street is one which can be made up at the owner's expense, as to informality in the notices, etc., as to the sufficiency or reasonableness of the works, and as to the apportionment of the expenses, are to be determined before the works are actually executed.

This more recent enactment is that under which most of the private streets are now made up.

The period usually allowed by the Local Government Board for the repayment of Loans for Private Streets Works is from four to six years.

Plans, Sections, and Estimates. Before a local authority gives the owners notice to make up a street, their engineer must prepare plans and sections, which should be on a scale of not less than 1 in. for 88 ft. for a horizontal plan, and on a scale of not less than 1 in. for 10 ft. for a vertical section, such plans, with the estimate, being deposited in the council's offices, and open at all reasonable hours while the notices run, for the inspection of all persons interested therein.

Before the preparation of such plans and sections, it will be necessary for the engineer to make an accurate survey of the street or streets to be made up.

Each frontage is measured and entered in a book, these dimensions acting as a check to the plotting of the various points taken from the offsets off the chain line.

Plans should be neatly and clearly drawn ; if the plans are on loose sheets, there should be a title and scale on each sheet, and the date, with the name of the engineer clearly written in the right-hand corner.

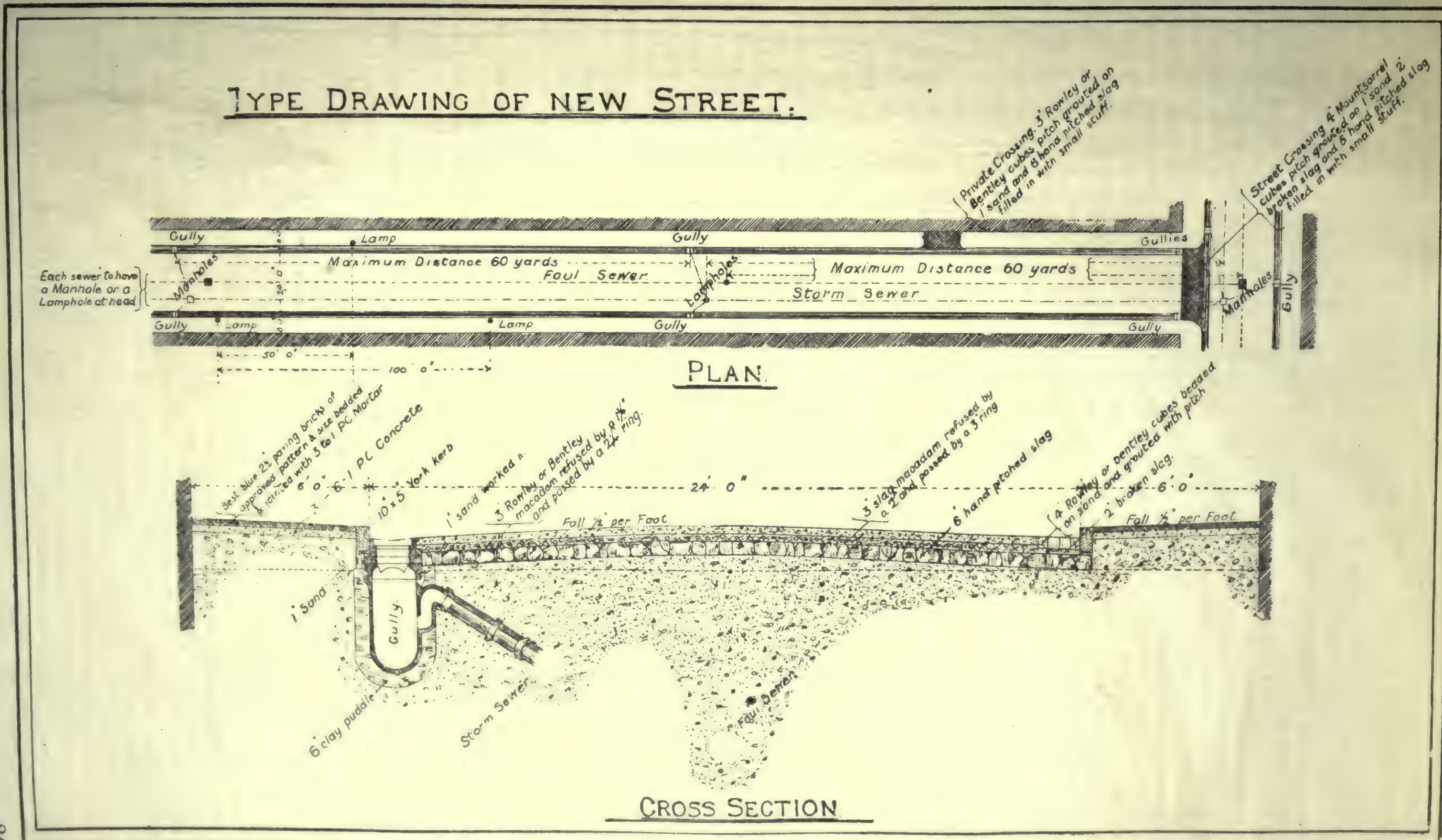
Details, such as manholes, type of gully, paving, etc., should be drawn to a large scale, with figured dimensions.

The Preliminary Survey. The plans and detailed section can be prepared only after an accurate survey of the streets. The section should show a horizontal "datum line," and lines showing the "formation level," and "finished surface" of the proposed works. Figures should also be given on the datum line for the horizontal distances, corresponding exactly with those on the plan, and the heights of the surface of the ground above datum require to be marked at intervals, as well as the depths of the sewers with their cross-sectional dimensions and gradients distinctly marked upon them.

A detailed estimate, showing particulars of the probable cost of the whole works, including a commission of 5 per cent. (which is allowed under Sec. 9) in respect of surveys, superintendence, and notices, should be prepared and must include provision for sewering, levelling, paving, metalling, channelling, kerbing, making good, and providing proper means of lighting.

Each street to be made up must be kept entirely distinct. Fig. 13 illustrates the laying out and making up of a new street ; Fig. 14 is the plan of a private street showing apportionments.

Apportioning Cost Among Owners. Under the Public Health Act, 1875, the principle adopted in making the apportionment is based on frontage only, but the Private Streets Works Act, 1892, gives the local authority power to decide whether the apportionment is to be made according to the frontage only or to take into account the degree of benefit derived by any premises having access from the street, and the amount of work already done by any of the owners. Therefore, before the engineer proceeds



13. DIAGRAMMATIC REPRESENTATION OF THE LAYING OUT OF A NEW STREET

to prepare the provisional apportionment, he must be clear on these points.

The provisional apportionment should show the amounts charged on the respective premises, the names of the respective owners, or reputed owners, also whether the apportionment is made according to the frontage of the respective premises or not, the measurements of the frontages, and the other considerations (if any) on which the apportionment is based.

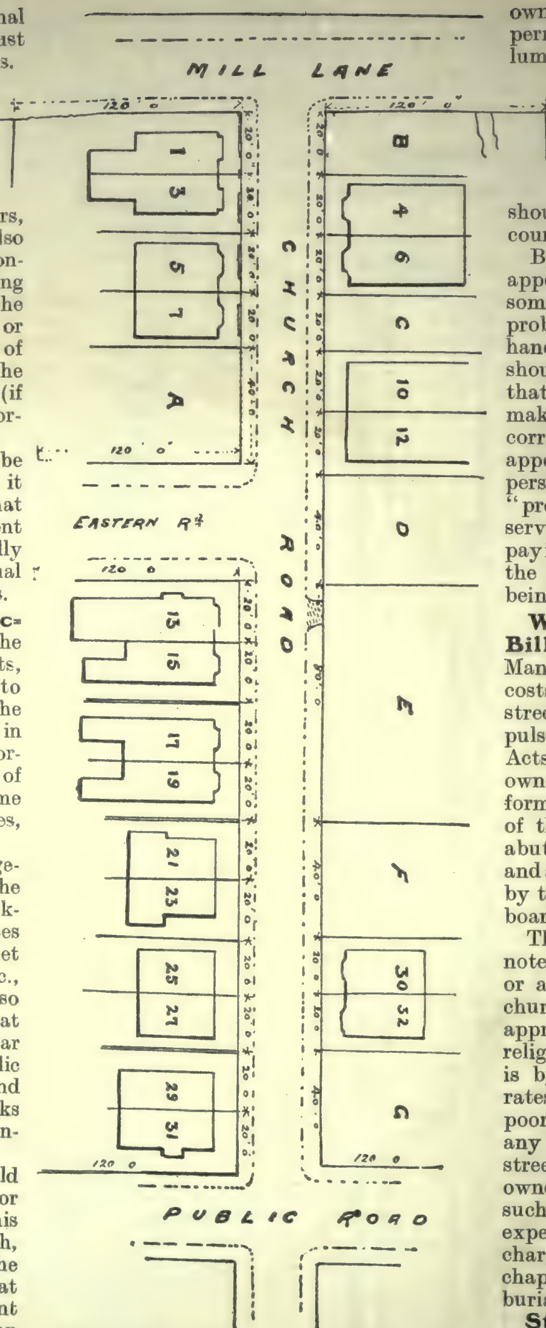
This work should be accurately done, as it must be remembered that the exact measurement of a frontage is usually known to the individual who owns the premises.

Street Intersections. As regards the intersections of streets, the usual practice is to include the cost of the intersections of streets in the amount to be apportioned over the whole of the frontages in the same way as manholes, gullies, and lamps.

The Metropolis Management Act, 1862, is the only Act expressly making the owners of houses and land in the street liable for the paving, etc., of intersections, and so it may be presumed that the omission of a similar provision in the Public Health Act, 1875, and Private Streets Works Act, 1892, was intentional.

The engineer should allow a fair margin for contingencies, and his estimate should be high, rather than low, as he must bear in mind that his final apportionment must not be more than 15 per cent. in excess of his estimate.

Final Apportionment. The preparation of the final apportionment is the last duty that the engineer usually has to perform, and he should exercise care that the charges in his apportionment are for the works described in the notices served upon the owners. It will not be permitted for him to lump the costs of a group of streets together, and apportion them amongst the owners of all. An apportionment, if requiring to be corrected, should be laid before his council again.



14. PLAN SHOWING APPORTIONMENTS UNDER PRIVATE STREET WORKS ACT, 1892

By the time the final apportionment is ready some property will most probably have changed hands, and the engineer should bear in mind that it is his duty to make the necessary correction on the final apportionment, as the person upon whom the "provisional" notice was served cannot be made to pay if he has ceased to own the property, the charge being on the properties.

Who Pays the Bill. By the Metropolis Management Acts, the costs of paving a new street under the compulsory powers of the Acts, are payable by the owners of the houses forming the street, and of the land bounding or abutting on such street, and are to be apportioned by the vestry or district board of works.

The engineer should note that the incumbent or any minister of any church, chapel, or place appropriated to public religious worship, which is by law exempt from rates for the relief of the poor is not liable to any expenses in private streets works, as the owner or occupier of such place, nor is any expense deemed to be a charge on such church, chapel, churchyard, or burial ground.

Street-Naming & House-Numbering. It was not until the commencement of the present century that inconvenience was apparently felt from the want of any distinguishing names of streets, or numbers to houses.

The Towns Improvement Clauses Act, passed in 1847, gave power to local authorities to cause

names of streets to be marked or painted on a conspicuous part of some house, building, or place, and also power to compel occupiers of houses to mark their houses with approved numbers.

Names of streets should be marked up in such a way as to be legible both by day and night. The best description of street name-plates are white glazed china tiles, 6 in. square, on which either blue or black letters are burnt in, one letter on each tile. These are fixed by chasing them into walls of buildings and setting in cement.

The best method of house numbering is by allotting even numbers on one side of the street, and odd numbers on the other side.

Dedication as Public Highways. The parties proposing to dedicate a new road laid out in rural districts as a public highway, must give the engineer and surveyor of the local authority three months' notice in writing of such intention, and further construct the same in a substantial manner, and of the width required by the Act to the satisfaction of the surveyor and two justices who, on receiving such notice, shall view and certify the same, when, after being used by the public and kept in repair by the said party for a period of twelve months, such road shall become a dedicated highway repairable by the inhabitants at large.

Under the Public Health Act, 1875, the local authority may by notice in writing declare a street to be a highway repairable by the inhabitants at large, after the works specified by them have been executed, provided that no such street shall become a highway so repairable if within one month after such notice has been put up the majority of the owners of such streets object thereto.

Under the Private Streets Works Act, 1892, a local authority may take over a street in a similar manner whenever *all* or *any* of the works specified by them have been executed.

Setting out Footpaths. The model bylaws made by the Local Government Board respecting new streets require that all footpaths of a street shall be of a width not less than one-sixth of the entire width of the street.

The following is an explanatory example of this requirement:

Entire width of street.		Width of path on *each* side.		Width of carriageway.	
Ft.	In.	Ft.	In.	Ft.	In.
60	0	10	0	40	0
50	0	8	4	33	4
42	0	7	0	28	0
40	0	6	8	26	8
36	0	6	0	24	0

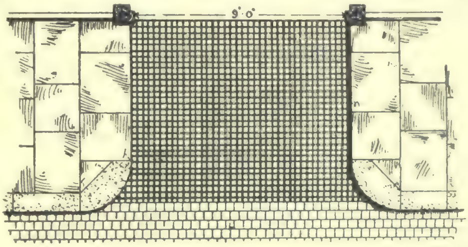
The slope (cross fall) from back edge of path towards the kerb to fall at the rate of one-half of an inch in every foot of width, if the footpath be not paved, flagged, or asphalted, and at the rate of not less than a quarter, and not more than one-half of an inch in every foot of width if the footway be paved, flagged or asphalted.

In excavating to the required depth for paving the best method is to put wooden pegs so that the upper ends represent the finished surface, and then to excavate to the required depth below the top of the pegs.

In practice, paths are usually laid to the following table, which, it will be observed, complies with the above requirements.

Nature of Paving.	Cross fall, per foot of width.
Asphalt	$\frac{1}{4}$ in.
Bricks	$\frac{3}{8}$,,
Concrete	$\frac{1}{4}$,,
Gravel	$\frac{1}{2}$,,
Stone (artificial and natural) ..	$\frac{1}{4}$,,
Tar	$\frac{3}{8}$,,

The height of the kerb or outer edge of the footpath, except in case of crossings paved or otherwise formed for the use of foot passengers, shall be not less than 3 in. at the highest part of the channel, and not more than 7 in. at the lowest part of such channel.



15. PLAN SHOWING PRIVATE CARRIAGE ENTRANCE ACROSS A PUBLIC FOOTPATH

The reason for this requirement of the Local Government Board is that a height of less than 3 in. would render it possible for vehicles to drive on to the footpath, or for the water in the channel to overflow it, and with a height of more than 7 in. it would be inconvenient for foot passengers. Where it is necessary to construct a carriageway entrance across a path, vitrified bricks or granite setts should be laid on concrete [15].

[See Kerbing and Channelling, page 2326, for examples in actual practice.]

Asphalt. Asphalt is largely employed as a paving material for footways. It makes an excellent footpath, being durable, non-slippery, expeditiously laid, pleasant to walk upon, and not glaring to the eyes.

Unfortunately, on account of what is technically termed *creeping*, it cannot be laid on paths having a considerable inclination, or cracks occur with increase.

Mastic asphalt is more commonly used upon footpaths than *compressed* asphalt. Asphalt, properly so called, is a natural compound of carbonate of lime and bitumen, and is found principally in volcanic areas, the proportion varying from 7 per cent. bitumen and 93 per cent. carbonate of lime to 20 per cent. bitumen and 80 per cent. carbonate of lime. Men of erudition have asserted that it was the pitch used to make the ark watertight, and that it

was the slime used as a mortar in the construction of the Tower of Babel.

Manufacture of Mastic Asphalt. The process of manufacture into a mastic or semi-liquid state is as follows: the pieces of raw rock, weighing ¼ cwt. to ½ cwt. each, are placed in an asphalt crusher, where they are broken into small pieces. After passing through the crusher, the asphalt is carried up by elevators to the disintegrators, which run at a speed of 1,800 revolutions per minute, and is ground to a very fine powder.

This powder is then put into specially-made cauldrons, and gently boiled and worked by agitators with certain proportions of refined bitumen (added as a flux), and when heated to a temperature of about 400 F., a mixture of fine Bridport grit is added (in making mastic asphalt), and then roughly incorporated with the asphalt by the rotary working of the agitators. It is then turned out into iron moulds, forming the well-known cakes, which weigh about ½ cwt. each. These cakes are broken up into pieces on the site where the asphalt is to be laid, and placed into small portable cauldrons with just sufficient bitumen as flux, and, when properly heated, the asphalt mastic is ready to be spread over the cement concrete surface to the thickness required. It is then turned into iron moulds, forming the well known cakes, which weigh about 56 lb.

Asphalt Laying. These cakes are usually sent by the manufacturers to the site where the paving is to be laid, and here they are remelted in small round street boilers on wheels with a fire under them, to which is added from 30 to 40 per cent. of fine, clean, dry limestone grit. If silicious grit only can be obtained, it should be as fine as sea sand. When ready for use it should be hot enough to vaporise a drop of water. It is carried in pails, and spread, by means of wooden hand floats, over a prepared smooth foundation of 3 in. of concrete (6 to 1) previously allowed to dry. Silver sand is then spread sparingly over the surface and rubbed in by floats. In six hours the footway is ready for traffic. One ton of asphalt covers 30 sq. yd. when laid 1 in. thick, which is the usual thickness adopted for paths. The advantages of asphalt pavements are durability, a smooth surface unbroken by joints, a good foothold, even and regular wear, and an impervious character.

Owing to the substitution of inferior material made from gas tar, Stockholm tar, hard pitch, and ground limestone mixed with bitumen as asphalt, it is essential that the asphalt to form the pavement should be specified to be composed of pure natural rock taken from the mines of the French (or other approved) Asphalt Company.

Bricks. Blue brick-paving for footpaths is one of the oldest materials. Buff granite vitrified bricks, made solely from the fine granite clays of South Devon, have come into general use chiefly owing to their toughness, and their colour, which gives an improved appearance to the paving, presenting a very bright and pleasing effect when laid. Methods of laying bricks to various patterns are shown in **16**.

The first essential is the right material, which will produce a tough and hard brick, and this must be treated in a way to develop its best qualities and avoid the defects which in many instances have given paving-bricks a bad name. The firing must have the most careful attention, or in this process the best of material treated by the best methods will be rendered worthless for paving.

Paving-bricks differ from ordinary bricks in that they are thinner, being only 2 in. thick, and are also harder and more compact.

Concrete. By concrete or cement paving is meant the inch of fine stuff which is laid on a coarse concrete foundation.

The use of concrete, as a monolith, as a paving material for footpaths, has made great progress during recent years, and in nearly every town in the United Kingdom, more or less, concrete may now be seen as a pavement. It is one of the cheapest and most durable paths which can possibly be formed.

The following may be taken as a fair description of the manner in which in situ concrete footpaths should be constructed.

Laying Concrete Footpaths. The foundation is excavated to a depth of about 6 in. below the finished level, and a bed of gravel 1 in. in thickness is then laid. A thickness of about 3 in. of clean hard stone is next laid, and well watered and rolled. The footpath is then divided into bays 6 ft. in width with strips of soft wood, and each alternate bay completed by laying upon the stone foundation 2 in. of carefully-prepared concrete composed of one part Portland cement, two parts coarse clean gravel, or other suitable material, passed through a 1-in. screen, and two parts of clean, sharp sand, which must be well beaten into place; and before it is set a finishing coat 1 in. in thickness of concrete, composed of one part Portland cement to two parts granite chippings, is added and brought up to the finished surface of the footpath, being well trowelled and smoothed into place. The strips of wood are removed as the work is finished.

The concrete is thus laid in bays to allow for expansion and to prevent the surface from cracking or gaping open, which is liable on the changes of temperature on large exposed surfaces.

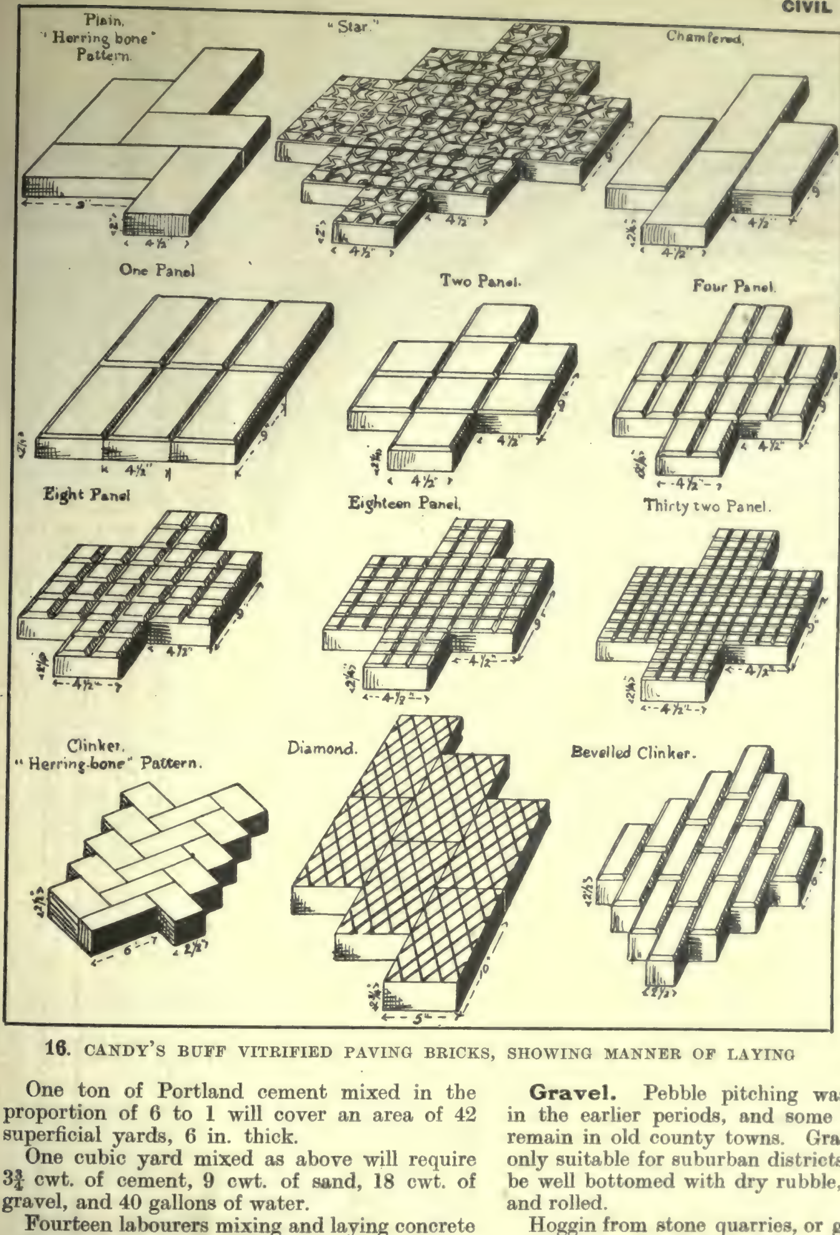
Laying Concrete Paving. In laying insitu concrete paving, the following points should be observed:

(*a*) From October to March is an unsuitable time for laying, owing to the frosty weather.

(*b*) It is better to avoid extreme heat, as the sun takes the moisture out of the upper face before the cement has time to set.

(*c*) It is advisable that the ground should be wetted before it is laid, and the finished surface should be protected by damp bags or planks for a week or two before being used for traffic.

(*d*) Beach shingle is preferable to crushed granite, but the sand should be carefully screened from the shingle.



16. CANDY'S BUFF VITRIFIED PAVING BRICKS, SHOWING MANNER OF LAYING

without any signs of wear being visible, and in 1892 a test was made of a portion of the said paving, when 1 sq. ft. was crushed at 562·4 tons.

The paving consists of a layer of Thames ballast concrete, 2 in. thick, laid on a foundation of 4 in. of clinker or brick rubble. On the ballast concrete a layer of granite concrete 1 in. thick is laid, each layer being well worked so as to remove cavities. The surface of the last layer is trowelled to a fair face, which is then sanded and rolled. The concrete is laid and finished off in panels, and can be left either in grey or red colour.

One ton of Portland cement mixed in the proportion of 6 to 1 will cover an area of 42 superficial yards, 6 in. thick.

One cubic yard mixed as above will require $3\frac{3}{4}$ cwt. of cement, 9 cwt. of sand, 18 cwt. of gravel, and 40 gallons of water.

Fourteen labourers mixing and laying concrete will complete about 135 superficial yards per day of 10 hours.

Stuart's Granolithic. *Stuart's Granolithic* is one of the best known monolith pavings. Granolithic is the name that was coined for the paving by the inventor, who, knowing its great value and qualities, patented it throughout the world.

The surface is indented by the use of a spiked roller, with a view of preventing slipperiness.

During 17 years that a piece of this paving was laid in Leadenhall Street, London, it was computed that 52,000,000 people passed over it

Gravel. Pebble pitching was much used in the earlier periods, and some portions still remain in old county towns. Gravel paths are only suitable for suburban districts. They must be well bottomed with dry rubble, well drained and rolled.

Hoggin from stone quarries, or gravel obtainable from Sevenoaks or Croydon, is the best material for binding and forming a good surface.

A good path for country roads and lanes, and one which is found to be firmer and more comfortable to pedestrians than ordinary gravel and beach paths, is made to the following abbreviated specification :

FOUNDATION. Well formed and left loose.

BOTTOM LAYER. Four inches of chalk, brick rubble, coarse clinkers from furnaces, or iron clinkers from a local foundry, well watered and rolled.

SECOND LAYER. Two inches of fine ashes well consolidated.

TOP LAYER (Finished surface). One inch of finely-sifted ashes, burnt brickdust, or macadamised road siftings, well watered and rolled.

Such a path will wear well, but it is liable to a growth of vegetation.

Artificial Stone. The manufacture of artificial stones is not altogether to be classed as a new art, for our forefathers made use of lime burnt from cockles and other shells to mix with sand. A strong material was made from *terra puzzolana*, imported from Civita Vecchia, and it was with this that John Smeaton cemented together the granite blocks of the Eddystone Lighthouse two centuries ago. As a paving material the merits of Victoria stone cannot be surpassed. It is composed of finely-crushed granite from Groby, in Leicestershire (washed by patent machinery), and Portland cement, carefully selected, and is manipulated and moulded, and subsequently steeped in a patent solution of natural, soluble silica, by which it is hardened, and rendered practically non-porous.

The crystals of the Leicestershire granite are regular in character, being of moderate size, and well cemented by a paste, which the analysis shows to be unusually free from destructive alkaline ingredients. The small size of the pieces of granite used in this manufacture renders the presence of the alkalies practically innoxious, because the artificial cement used surrounds these pieces with a protective coating, and prevents the possibility of any dissolving action by the air or moisture.

Making Artificial Stone. Sample lots of Portland cement are taken and made into briquettes, having a breaking surface of 1 sq. in. These briquettes are exposed to the air for 24 hours and then immersed in water, where they remain for six days, when they are tested by a double-lever testing machine.

The aggregate and cement, having become in a manner guaranteed by the treatment and precautions described, are mixed together in a dry state by machinery, and the water is then added in a careful manner, so as to avoid the danger of washing out any of the fine and more soluble portions of the cement; and before any initial set of crude concrete mixture can arise it is put into the moulds, in which it is carefully worked, in order to fill up the angles and sides, thus ensuring accurate arrises all round. After having remained in the moulds a sufficient length of time, they are taken to the tank in the silicating yard (protected from the weather), and covered by the silicate solution, where they remain until the proper beneficial properties have been imparted.

The machinery required for the conversion of the crude silica into silicate is of a special character. The caustic soda is obtained from the best sources and of the purest quality, because the presence of sulphur, which sometimes exists in carelessly manufactured soda, has a most prejudicial influence on the silicate.

The slabs, after being taken from the tanks, are stacked in the yard, where they remain to season, and are taken away in order of their age.

Varieties of Artificial Stone Slabs. Paving slabs are made of various sizes and thicknesses; those of 2 in. weigh 25 to 26 lb. the foot super, and are convenient to handle.

Street corners are made with patent slabs moulded to radiating and other rectangular shapes to fit the radius, and the difficulties and waste attending cutting the stone at random are avoided [**17**].

The granite used for the *Imperial* slabs is a mixture of Aberdeen, Guernsey, and Guenast (Belgium).

The *Adamant* slabs are composed of finely-crushed Aberdeen granite and Portland cement. Other artificial stone slabs are composed of finely-broken granite York stone chippings from stone slag and destructor clinkers mixed very accurately with Portland cement and subjected to different processes. Municipal authorities largely manufacture their own artificial slabs by the use of hydraulic artificial stone presses, and with a staff of three men an average of 35 slabs, measuring 3 ft. by 2 ft., can be manufactured in an ordinary working day.

Laying Artificial Slabs. Much depends on the way in which such slabs are laid. Before laying, the area to be paved should be excavated, or filled in with good dry material well rammed, as may be required to suit the intended levels of the path. On this a layer of poor hydraulic lime-mortar is spread, on which the slabs are well and truly bedded. The slabs should be of such dimensions as to break joint when laid [**17**]. Care should be taken to allow between the paving and building a little space (say, ½ in.), which should be filled in with sand, so as to allow for any disturbance of the ground caused by frost. When laid, the slabs should be run in with grout made from mortar similar to that used for bedding.

Where the natural ground is of clay or chalk it is advisable to put in a layer of ashes or broken clinkers, 3 to 4 in. in depth, to form a dry foundation under the slabs.

The percentage of material broken or cracked in lifting and relaying over pipe trenches is found to be greater with artificial stone than with natural stone. This is partly accounted for by the close joints of the artificial slabs and the brittle nature of concrete. The average waste in artificial stone is estimated at about 3 per cent., but this depends very largely on the manner of bedding and jointing, and on the care used in laying, lifting, and relaying.

Wear of Artificial Stone. Artificial slabs are not found to be more injuriously affected than natural stone by severe frost, and for busy streets this paving is pushing in situ concrete paving out of the field, owing to the practicability of lifting and replacing when electric light, gas, or water trenches have to be taken under the pavement.

The period allowed by the Local Government Board for repayment of loans for artificial pavement seems now to be about the same as that for natural stone. Formerly a shorter period for repayment was given, but this doubtless depends upon the special circumstances in each case.

Natural Stone. For many generations York stone flagging was regarded as the criterion material for footpaths. Without doubt it is the most comfortable to walk upon.

York stones of 3 in. thickness, after being laid for twenty-five years in Kensington, where a large quantity of this stone is laid, were taken up, refaced, resquared, and relaid in a subsidiary street, where they are likely to last another twenty-five years, and the best of it can then be worked up and laid in narrow courses round public parks and pleasure grounds, the remainder coming in useful for road foundation.

It will thus be seen that York has several lives. Lazonby (Cumberland) flags have been in use in Carlisle from time immemorial; they are very durable, and when laid on a good foundation, on a 1-in. bed of good mortar, have been known to wear evenly down from 3 in. to $1\frac{3}{4}$ in. in thickness; but it is very difficult to get these flags of the same quality as thirty years ago, though whole mountains have been rooted into. Caithness (Scotland) flags are the other only natural stone to compete with York. It has been ascertained that the resistance to a gradually increased bending stress between York and Caithness flagging is in favour of the latter. In the West of England the Devonian limestone flagging is much used.

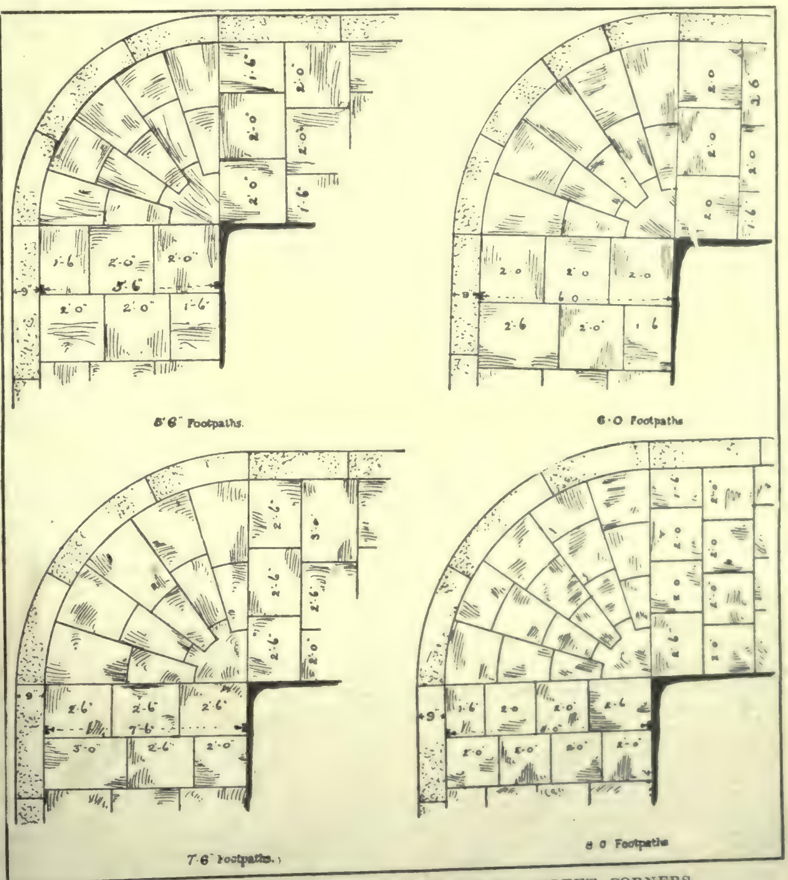
The foundation for flags should be good. Hard core is that most generally employed, and, owing to the uneven surface of all flags, it is necessary to bed on sand. The joints should be set flush, and each stone pointed in properly mixed blue lias mortar.

Tar. Tar-paved footpaths are undoubtedly the most popular formation where the traffic is not too heavy, and the manufacture and laying of this class of paving deserves much more attention than is generally bestowed on it.

In no case should gas tar be used until it has been stored for about six months, so that the volatile oils and whatever water may have been in the tar has had time to escape or come to the surface. The tar should then be drawn from the bottom of the tank.

Making Tar Paving. In manufacturing tar paving the common practice is to heat the stone (Kentish ragstone, Derbyshire limestone, chippings or gravel) proposed to be used in a heap or clamp, the clamp being fired at the bottom, and coke breeze or small coke being mixed with the stone. When the fire is exhausted the clamp is allowed to remain for a few days while it cools, and the heat gets more uniformly distributed.

Another practice is to heat the stone on a hot hearth, on which the stone can be raised to such a temperature that it will absorb as much tar as possible without ignition. Hot tar is added to the heated stove, and the same turned over with hot shovels until all parts of the stone are well coated. Tar paving thus made should be stored for at least three months before being used. In storing, it should be kept as free as possible from damp. Tar paving improves if kept for a year or two, although the nature of the tar, to all appearances, has disappeared. It can be freshened with a little refined tar before being used.



17. PATENT ARTIFICIAL STONE SLABS FOR STREET CORNERS

Foundation for Tar Paving. The stones used should be of uniform size, machine broken, and screened ; those for the bottom layer should not exceed 1 in. in diameter, and all the stones used should be retained on a sieve of $\frac{5}{8}$ in. mesh. The stones for the top layer should pass through a sieve having $\frac{3}{8}$ in. mesh, and be retained on a sieve of $\frac{1}{8}$ in. mesh.

The ground of the area proposed to be tar paved should be levelled, allowing for a fall of not less than 1 in. in 3 feet.

The foundation on which the tar paving is to be laid should be composed of broken brick, ashes, or other similar hard core, not less than 3 in. in thickness, and well rolled until solid, with a fairly smooth and level surface. In situations where there is an existing foundation of gravel or other suitable material, this requires to be levelled only to falls as mentioned above for "ground-work," and well rolled ; all soft places excavated and made good with suitable hard core, as previously specified for new foundations.

Laying Tar Paving. The tar paving should be laid in two coats, each coat being separately well rolled with a roller weighing not less than 12 cwt. The bottom coat should consist of material of $1\frac{1}{4}$ in. gauge, and the top coat of material of $\frac{3}{8}$ in. gauge. The surface, when being finished, ought to be sprinkled with white Derbyshire spar of $\frac{1}{2}$ in. gauge, and before final rolling, dusted over with finely-screened spar or limestone dust, to leave a white smooth surface on completion.

The thickness of the work should vary according to the traffic for which it is intended, and should generally agree with those given below for the various purposes mentioned—*viz.* :

PATHS (*with ordinary traffic*).

Work to be laid $2\frac{1}{2}$ in. thick.

Bottom coat $1\frac{3}{4}$ in. thick, of $1\frac{1}{4}$ in. gauge material.

Top coat $\frac{3}{4}$ in. thick of $\frac{7}{16}$ in. gauge material.

PATHS (*with light traffic*).

Work to be laid 2 in. thick.

Bottom coat $1\frac{1}{2}$ in. thick, of $1\frac{1}{4}$ in. gauge materials.

Top coat $\frac{1}{2}$ in. thick, of $\frac{7}{16}$ in. gauge material.

Tarring and sanding (or, as it is termed, "dressing") the surface of tar paths should be done during dry weather, the first summer after the tar paving is laid, and afterwards triennially.

The tar used for this purpose should be well seasoned, or refined tar, heated in a caldron, with a little pitch. After the surface of the path is swept clean, and the hot tar well rubbed in, a layer of dry sharp sand, about $\frac{3}{16}$ in. thick, is spread on the tar so as to keep it from adhering to pedestrians' feet. This sand works into the tar, and forms a thin coating, which preserves the life of the path considerably.

Tar pavements must not be compared with asphalt or paved paths, but only looked upon as a substitute.

Roads concluded

STATISTICS OF COST AND WEAR OF MATERIALS USED FOR FOOTPATHS

Paving.	Description of Paving.	Thickness in inches.	First cost per superficial yard.	Average cost of maintenance per superficial yard.	Life of paving in years.	Remarks.	Number of years usually allowed by Local Government Board for repayment of loan.
Asphalt	(Concrete foundation)	3	—	—	—	—	—
	Asphalt ..	1	7/9 to 8/6	—	18	The cost is dependent on the quantity required.	10
	,, ..	$\frac{3}{4}$	6/6 to 7/0	—	15		
	,, ..	$\frac{1}{2}$	5/6 to 6/0	—	12		
Bricks	Blue	2	5/0 to 6/0	—	12	This paving can be laid at a much less cost in Staffordshire and the Midlands.	10 to 15
	Buff	2	5/0 to 6/0	—	—	—	—
	Red	2	3/6 to 5/6	—	—	—	—
Concrete ..	Insitu	3	3/0 to 4/0	—	—	Strength of the matrix has to be taken into account.	10 to 15
	,, ...	2	2/0 to 3/0	—	—		
Gravel	Ordinary ..	4	1/0	1d.	3	Cost depends on locality and materials obtainable.	5
Stone (artificial)	Adamant flags	2	5/0	—	12 to 14	—	—
	Imperial ,,	2	4/9	—	12	—	10 to 20 (according to composition of material).
	,, insitu	2	4/0	—	—	—	
	Stuart's flags	2	5/6	—	—	—	
	,, insitu	2	4/0	—	—	—	
	Victoria flags	2	6/0	—	15 to 20	—	
	York (hard) ,,	$2\frac{1}{2}$	7/0	—	—	—	
Stone (natural)	York ,,	3	8/6	$4\frac{1}{4}$d.	25	1s. per yard less if laid on a ballast foundation instead of concrete, and considerably less when laid in Yorkshire and North of England.	20
	,, ,,	$2\frac{1}{2}$	7/3	—	20		
	,, ,,	2	6/6	—	15		
Tar	Limestone ..	3	2/6	$\frac{1}{2}$d.	10	A cheaper material is laid in some localities.	10

A STUDY OF LIGHT

Various Theories Regarding Light. Colour. Light Waves. Speed of Light. The Ethereal Keyboard. Shadows. Intensity, Reflection, and Absorption of Light

Continued from page 2319

By Dr. C. W. SALEEBY

THE best fashion in which we can approach the gigantic subject of *light* will be by a brief historical retrospect of our knowledge. To this there needs only the preliminary statement which would establish the parallelism between light, sound, and heat in respect of the distinction that must obtain between the physical and psychological aspects of the subject. There is an objective reality corresponding to light—to what we call light. It is not in itself luminous, but ranges everywhere throughout the universe in utter darkness until it reaches a seeing eye. The blind man enters into sunlight; the light is there, but he cannot see it. If we were all blind, if the human race had happened never to develop the faculty of vision, we should not find it difficult to understand the objective similarity between waves of light, which we happen to be able to see, and the waves which constitute, for instance, the Röntgen rays, and which we are unable to see.

Theories of Light. It is with the great name of Newton that we may begin. In his day there were two rival theories of the nature of light—one known as the *corpuscular* theory, the other as the *wave* theory. The former is also known as the *emission* theory or *emanation* theory, and the latter as the *undulatory* or *vibratory* theory. It was generally accepted, and, of course, still is accepted and proved, that light consisted in the motion of something. This could no longer be doubted when the astronomer Römer, by making observations upon the moons of Jupiter, showed that light took time to travel from one place to another. When this fact was established, it became plain that men must seek for the nature of this something which moves.

The corpuscular theory of light held that the sensation of light is created by a stream of tiny particles which are sent outwards in straight lines from all luminous bodies, and which strike the eye. The wave theory declared that there is no motion of any substance through space, but only that special form of motion which we call wave motion. But this supposition necessitated the further supposition of a something in which the wave occurred—the something which may be called the *ether* or the *luminiferous*—that is to say, *light-bearing ether*. Various other branches of physics lent their support, by way of analogy, to one or other theory. The corpuscular theory was supported by already existing corpuscular theories of heat, electricity, and magnetism. (The reader of the course on chemistry will prick up his ears at hearing of this old corpuscular theory of electricity, for it will remind him of the corpuscles negatively electrified, of which he has there read.) The study of acoustics, on the other hand, lent considerable support to the wave theory of light. Acoustics was already in a comparatively advanced state. The very simple observation that a sounding body is found to vibrate when touched had early led men in the right direction. If sound, then, as no one could doubt, consisted of waves, why not light also?

The Battle of the Theories. Each theory had its supporters, while each certainly had its difficulties. The corpuscular theory of light seemed to be thoroughly compatible with the fact that light moves in straight lines. The geometry of straight lines and their relations corresponded admirably with the geometrical facts of light—its reflection and refraction. The fact of sharp shadows also seemed to favour the emission theory, and to militate against the wave theory.

The great mind of Newton had to choose between the rivals; but, primarily, Newton was not a mere theorist, but a great discoverer, and some of his discoveries in optics tell in favour of the one theory and some in favour of the other. It was in the year 1672 that Newton communicated to the Royal Society his great discovery of the compound nature of white light. As most people know, he darkened his room, cut a hole in the shutter, placed a prism in the path of a ray of sunlight entering, and so broke it up into its component parts. He says, "Light itself is a heterogeneous mixture of differently refrangible rays." Later, he replaced the hole by a slit—though it has been stated that he did not do so—and thus obtained a band of colours.

The Nature of Colour. We cannot do better than quote Newton's own words: "1. As the rays of light differ in degrees of refrangibility, so they also differ in their disposition to exhibit this or that particular colour. Colours are not qualifications of light, derived from refractions, or reflections of natural bodies (as 'tis generally believed), but original and connate properties, which in divers rays are divers. Some rays are disposed to exhibit a red colour and no other; some a yellow and no other; some a green and no other, and so of the rest. Nor are there only rays proper and particular to the more eminent colours, but even to all their intermediate gradations.

"2. To the same degree of refrangibility ever belongs the same colour, and to the same colour ever belongs the same degree of refrangibility. The least refrangible rays are all disposed to exhibit a red colour, and those rays which . . . . exhibit a red colour are all the least refrangible; so the most refrangible rays are all disposed to exhibit a deep violet colour, and . . . . those which . . . . exhibit such a violet colour are all the most refrangible."

In consequence of this pre-eminent discovery and others, Newton inclined towards the corpuscular theory, which we now know to be erroneous. The consequences for the advance of optics were lamentable. For the authority of Newton was so tremendous that the wave theory was delayed, one may say, almost for centuries before it recovered from his opposition. It is true that Newton recognised the objections to the corpuscular theory, but it is the characteristic of the followers of a great man not to see all round the subject as he does, but to jump at his main statement and ignore the qualifications.

The Wave Theory of Light. It was the great Huygens, a contemporary of Newton, who first paid to the wave theory of light the attention which was its due. Thereafter the theory was taken up by the mathematicians, though it never made any real headway until the magnificent work of Dr. Thomas Young, who was led to study light by means of his work upon the subject of the human voice for the purposes of a medical dissertation. This led him to study sound, and he records that he was overwhelmed by the analogy between certain of the phenomena of sound and those of colour. Thus he primarily attacked the subject not from the side of mathematics, but from that of experiment. He was led, however, to the works of the mathematicians who supported the wave theory, and came to the reluctant conclusion that Newton's objection to this theory—and especially the objection that no wave theory could explain the propagation of light in straight lines—could not really be sustained. Continuing to work at the subject, Young made the great discovery of the *interference* of light—a phenomenon which our previous reference to it under sound will make sufficiently intelligible for the present purpose. Young actually found how there are conditions in which the addition of light to light will cause darkness, and its removal will leave light.

Once the facts of interference were established it must surely have been impossible, we would think, for anyone to refuse to accept the wave theory, even though it necessitated the assumption of a luminiferous ether. Lord Brougham, alike ignorant and incompetent, made a celebrated attack upon Young in the "Edinburgh Review," so that, as Dr. Merz says, in his admirable account of the history of this subject, "The doctrine of the interference of light, the mainstay of the undulatory theory, was, like the atomic theory of Dalton, driven out of the country."

An Extraordinary Property of Light. The great labours of Young could not achieve real progress until his work was taken up by the Frenchman Fresnel, who dared to support Young in the very place (Paris) where the corpuscular theory had been so long maintained and apparently strengthened. Fresnel took up Young's experiments, beginning with the phenomena of interference and studying especially the coloured fringes that surround the shadows of small bodies placed in the way of a ray of light. He showed that the theory of wave motion, combined with the idea of interference, was not only compatible with the propagation of light in straight lines—which chiefly led Newton to reject the true theory—but actually explained such propagation. For Fresnel showed that all the sidewards-going waves, or almost all of them, interfered with each other, and so destroyed each other. And now a new difficulty arose. When a ray of light passes through certain crystals, such as Iceland spar, it is split up into two—a phenomenon which is called *double refraction.* Under these and other conditions, such even as simple refraction from any surface, light acquires an extraordinary property which Newton expressed by saying that it has *sides.* It will pass through a second obstacle if that be held at one angle, but not if the second object be then rotated through a right angle.

Polarised Light. Such light, by a very undesirable term, is said to be *polarised.* Now, this remarkable polarisation of light, to which we must, of course, return, would seem to be more or less explicable on the corpuscular theory, if one imagines the corpuscles to have particular shapes just as crystals have. It might be that they were all tilted in one direction or another, and thus could pass through some transparent body at one angle but not at another, just as a stout person may have to turn sideways to go through a turnstile. But the facts of polarisation could by no means be explained on any wave theory which asserted that light consists of waves of alternate condensation and rarefaction in the line of propagation, just as a wave of sound does. One cannot imagine the polarisation of a wave of sound or any similar wave. It cannot conceivably have sides.

Naturally, the discovery puzzled Young, and compelled him to admit that the balance of evidence almost seemed to turn against his wave theory. But Young was not to be beaten, and solved the difficulty in a similar fashion to that which Fresnel himself afterwards independently reached.

The Motion of the Waves. Young declared that if we assume the wave motion of light to be not to and fro in the direction of its motion, but to be *transverse*—that is to say, at right angles to its line of propagation—the facts of polarisation can be readily explained. The apparent *sidedness* of waves of light simply means that, under certain conditions, the transverse vibrations constituting light are deprived of their common character (which is to vibrate in all planes, up and down as much as from side to side), and are reduced to one plane. Let us imagine that this plane is up and down or vertical. We can readily understand that light, the vibrations of which have been reduced to this one plane, will be able to get through a transparent object only on certain conditions. To take an example, a man is mainly vertical, and can readily pass through a vertical door. Imagine the door rotated at right angles, the man will stick, the door will be opaque to him. But if we imagine the man multiplied by many men at all sorts of angles, it is evident that whatever the angle of the door, it will not be able totally to exclude him.

But to disprove the corpuscular theory of light, and to lay down the first foundations of the wave theory, was very far from completing the task. There remained, and still remains, indeed, the all but insuperable difficulty of comprehending the nature of the medium—the light-bearing ether—in which the waves of light are formed. To this subject, however, we need not return, as we dealt with it under Gravitation. At any rate, we have outlined the main features of the great contest between the two theories, and we may now turn to a more systematic study of our subject.

The Speed of Light. A brief discussion of the speed of light may legitimately be placed here, since the discovery that light has a speed at all was absolutely essential to the framing of the undulatory and emission theories alike. It used to be thought that light acted as we still believe gravitation to act—instantaneously. The fact that this is not so had to be discovered before any further advance in optics was possible. In 1675, the Danish astonomer Römer, working in Paris, studying the eclipses of the innermost of the four moons of Jupiter which were then known, found that it did not disappear behind Jupiter and reappear at the moments which he had calculated. The period of occultation varied sometimes by as much as a quarter of an hour. Especially was the moon delayed when Jupiter happened to be on one side of the sun and the earth on the other. The explanation seemed to him to be that when the earth and Jupiter are on opposite sides of the sun, the distance at which the eclipse of Jupiter's satellites is observed is greatly increased. Surely, then, light must take time to travel, and if it does so, not only will the fact explain the apparent delay in the eclipse, but, since the diameter of the earth's orbit is known, the difference between observation and calculation at different times—as, for instance, a quarter of an hour—will readily enable us to calculate the speed of light. By this and many other methods light is calculated to travel at the rate of about 186,200 miles per second. It is a fact of the utmost importance that, as we now know, the onward speed of light is *one and the same with the speed of other wave motions in the ether.*

The Keyboard of the Ether. And here we must dispose of a difficulty which is involved not at all in the physical nature of light, but in the physiological constitution of our own bodies. In the case of sound we saw that the air, for instance, is able to vibrate to and fro at a very large number of different rates per unit of time, out of which we can, so to speak, merely cut a slice, and call it sound. So far as we are concerned, there are sounds which are too low in pitch for us to hear, and sounds which are too shrill. The same is true of light. This perfectly elastic substance, the ether, is able to display transverse vibrations of many, or, indeed, any frequencies per second. From this indefinite series of vibrations we, with our limited eyes, cut out a slice and call it light. In studying sound we saw that the octave of a note has a frequency exactly twice as great as that note. Now, the eye is able to perceive, as light, ethereal waves of a series which just corresponds to one octave. The sound we know has a limit of nine to eleven octaves, but the eye is able to perceive only one octave of light. Above and below this there are more ethereal vibrations, the existence of which we can demonstrate indirectly, but which do not affect the retina, and to which, in short, we are blind, just exactly as if we were able to hear one octave picked out from the middle of the piano and were stone deaf to all the octaves above and below it.

Its "High Notes." The compass or gamut of the ethereal keyboard is daily being extended. Our knowledge of it, at present, is in a curiously imperfect condition; the whole keyboard is there in nature, but we only know, so to speak, a few notes here and a note there. Somewhere in what, for convenience, we may call the middle of the keyboard we have discovered a complete octave—the octave of light. At its upper limit, also, we have more recently discovered a few notes more which, since the last note that we can see we term violet, are distinguished as ultra-violet light, or, more accurately, the ultra-violet rays. Then there is a great gap in the keyboard which we are trying to reconstruct, or, rather, for which we are groping. There is somewhat dubious evidence in favour of the view that a few notes of this gap have been discovered during the past year or two. But if we grope on still further, passing a doubtless complete series of notes which are there, though we cannot discover them, we reach a few very *shrill* tones, so to speak, which are called the Röntgen rays, and which must later be discussed at length.

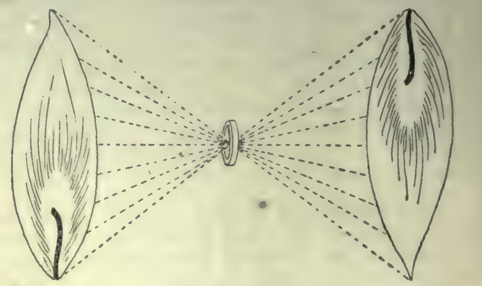
Its "Low Notes." Similarly, if we pass downwards from the central octave of which our eyes assure us, we reach, directly continuous with the red rays—themselves endowed with no small heating power—a series of heat rays. These are of very great variety. The great American physicist Professor S. P. Langley, whose death has just been announced, devised an amazingly delicate apparatus for the study of these ethereal waves, which, if our eyes were somewhat differently constituted, we should doubtless be able to see. The *bolometer* of Langley—an instrument so delicate that it would be able to record, at the distance of a mile and a half, the heat radiated from a human face—enabled its inventor to demonstrate the existence of a long and complicated heat spectrum precisely comparable to the spectrum of visible light. But even below this many notes have been picked out from the ethereal keyboard. Beyond the heat waves we may have to include the so-called N-rays of Professor Blondlot, about which such a furious controversy has waged for two years, and must certainly include electric waves, such as those of Hertz, and those, somewhat longer still, which are employed in wireless telegraphy.

Light and Electricity. Now, the reader must ponder upon the most important fact—already noted—which entirely consorts with the conception that light is only a visible octave, picked out by the eye from a keyboard of incalculable compass. All these rays or waves that we have described, from the Röntgen rays down to the longest known electrical waves, have one and the same onward velocity—the so-called velocity of light. Lastly, we may note that, as the reader of this and the companion course must have guessed, if we are to speak of electric waves and light waves as moving at the same speed and as fundamentally identical, plainly we must make the one term include the other, or invent a common term to include both. The former expedient is perfectly satisfactory, and nowadays we recognise in light, as we shall afterwards see, an electrical phenomenon. The reader will compare this statement with our study of the nature of matter in the course on Chemistry, wherein we came to the conclusion that matter itself must be regarded as an electrical phenomenon. So much for the modern extension of meaning of a term which literally means a peculiarity of amber.

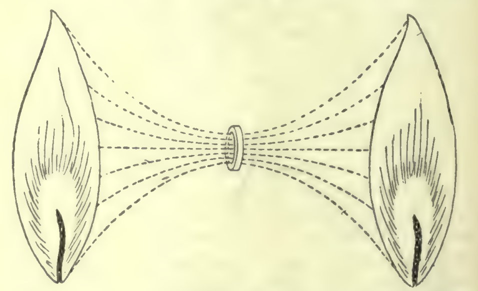
Having discussed the comparatively simple question of the speed of light, having insisted upon the enormous importance of the fact that it has a speed at all, and the scarcely less enormous importance of the fact that its speed is identical with that of a number of other forms of energy which do not at first appear to have anything to do with light, and is, doubtless, identical with the speed of a number of other forms of ethereal wave motion which have not yet even been discovered, we must pass to consider certain of the simplest facts of light; and, first, we may study that striking fact which is so characteristic of light, distinguishing it, apparently, from sound, and which Newton thought to be incompatible with the theory that light is a wave motion.

Light Moves in Straight Lines. This is the fact that light moves in straight lines—the fact of its rectilinear propagation. If we repeat the classical experiment of Newton—at any rate, to the extent of piercing a hole in a shutter—we find that we obtain an image of the sun upon the floor. It is, indeed, an image of the sun and not of the hole, since we may vary the shape of the hole as we please, but will still get the same result. We may notice also, in summer-time, how images of the sun are cast upon the ground by light passing between the leaves of trees. Everyone must have noticed also how, on a moonlight night at the seaside, one may chance to see a perfect image of the moon in any little pool of water that may have been left among the rocks. All these circumstances, not to mention the familiar form of the light which passes from a magic lantern, tend to favour the view that light moves in straight lines. Everyone has noticed this, again, when sunlight passes downwards in straight lines through breaks in distant clouds.

The Inverted Candle. Or we may perform a simple experiment by making a pin-hole in a screen and placing this near a candle, the flame of which is at the same height as the



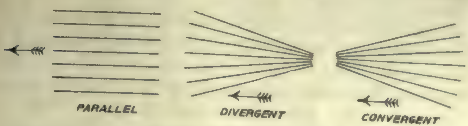
pin-hole. Now we find that the image of the candle is thrown upon any surface that may be placed on the far side of the screen; but it is an inverted image, the candle flame is upside down. This simple and startling experiment has an extremely simple explanation. Any reader can draw for himself the flame and its inverted image, having them opposite one another and placing between them a point, through which the rays from every part of the flame have to pass. If the rays are to pass in straight lines the image must be upside down. The second figure shows the curved course



necessary if the image were not to be upside down. The same is true of the image of the sun, if we could recognise it, in the case of our other experiments.

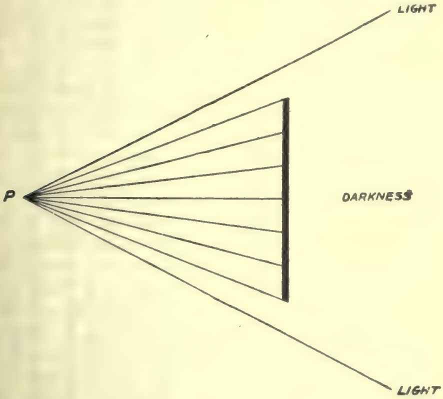
Pencils of Light. Strictly speaking, we cannot speak of a single ray of light, but must conceive of many rays forming a bundle or pencil. The rays in such a pencil may be moving in various directions relatively to one another, though, of course, each is rectilinear. When we refer to a very distant source of light, we may conceive of the rays forming a pencil as parallel. It is true, of course, that the rays filling the pupil of the eye never can be parallel, even when they come from the most distant star. Nevertheless, for all practical purposes, the rays transmitted, at any rate from a star, may be regarded as forming a parallel pencil, and indeed, for the ordinary purposes of eye testing, it is possible to regard as parallel the rays from objects that are not very many feet away. On the other hand, when a pencil of rays has passed through a lens, or when, for

instance, you read this page, the light forms divergent pencils. With a different shape of lens—such as each of us possesses in his own eye—the divergent pencil of rays may be converted into a convergent pencil [see illustration].



In this latter case it is, of course, evident that the rays must meet one another at a point, and this is known as the focus.

Kinds of Shadows. These simple distinctions enable us to understand the variations between different kinds of shadows. When a man makes "rabbits," and so on, with his hands in front of a magic lantern screen, sharp shadows are produced. The sharpness will be absolutely perfect under conditions which, perhaps, can scarcely ever be realised—that is to say, when the source of light is a luminous point and no more. In such a case, since light moves in straight lines, the placing of any object in the divergent pencil of light rays must necessarily produce an absolutely sharp shadow. There can be no complication, as the accompanying diagram shows. A certain number of rays are



cut off by the obstruction and a certain number escape. But the moment the source of light becomes anything other than a point, then every one of its points behaves as does the luminous point in the diagram ; and thus sharp shadows cannot be obtained. Thus, in the celebrated case of eclipses of the moon, where the earth intervenes between the sun and the moon, and where the eclipse is due to the falling of the earth's shadow upon the moon, we discover two distinct areas of shadow, one dark and known as the *umbra* or shadow, the other less dark, outside it, and called the *penumbra* or almost-shadow. In the case of the part of the moon which is covered by the umbra, the whole of the sun's light has been cut off. The area covered by the penumbra is cut off from part of the sun's light but not from all of it. If the sun were a luminous point, there could no more be such a penumbra than in the case of the accompanying diagram. If the reader will draw a second point, just above or below the point in the diagram, and then draw similar rays diverging from it, he will see how a penumbra or an indistinct edge to the shadow must necessarily occur.

Shadows of Sounds. And one more point concerning the rectilinear propagation of light. We have observed a contrast between sound and light, and have commented upon the very great discovery of Fresnel, which demonstrated that this rectilinear propagation is compatible with the wave theory of light if we assume the waves to be transverse, and if we invoke interference to explain the mutual destruction of all or nearly all sidewards-going waves. The point is, that we must not be confused in our notions of the movements of sound. As daily life teaches us, and as the study of echoes confirms, sound also moves in straight lines mainly. Thus, for instance, it is quite easy to produce what may be called shadows of sound. This fundamental fact of the rectilinear propagation of energy must never be forgotten if we are to hold intelligently Newton's first law of motion. We must connect in our minds not only the movement of a bullet or a planet, not only the movement of the molecule of a gas, which always goes straight on until it strikes something, but also those movements which we class as wave motion, whether these be to-and-fro waves in material media, or transverse waves in the ethereal medium.

The Intensity of Light. The reader will readily be able to guess that there is a simple law which determines the variations in the intensity of light with distance, and also the exact statement of that law. It needs only to remember the law of gravitation and the similar facts in the case of radiant heat and sound. The intensity of light varies at any point inversely as the square of the distance from the source of light. It can be shown that this must be so, whether the corpuscular theory or the wave theory of light be true. Various means have been adopted for estimating the intensity of light at any point. Such means are technically known as *photometers* (Greek *phos*, with root *phot-* =light).

Perhaps the oldest and simplest photometer is that invented by the celebrated and remarkable man Count Rumford, an American, who came to England and was a leading spirit in founding the Royal Institution. His real name was Thompson, a name which, sometimes with and sometimes without the "p," is also borne by three of the most distinguished of living physicists. Rumford's photometer is simply, in its essence, a screen of white paper, in front of which is placed an upright stick, capable of casting a shadow. If two sources of light be placed beyond the stick, two shadows will be cast. The eye is then able to compare the depth of the two shadows, and it is found that when sources of light of various strength are used, the

law of inverse squares is confirmed. This may be done by employing a standard source of light, such as the *standard candle*, to which we refer when we speak of candle power. On the other hand, if we assume the truth of the law of inverse squares, the photometer enables us to value or appraise the illuminating power of any new source of light. Another device is that of Bunsen, and depends upon the fact that a grease-spot on a piece of paper looks lighter than the rest of the paper if one looks through it at a source of light, but darker if the light and the eye be on the same side of it. Thus the intensity of light produced by two rival sources of illumination, one on each side, is equal when the grease-spot cannot be seen at all, and their value can be measured if their distances be compared. Very many photometers have been invented since these days, and those now used are very much more sensitive; but it would require a lot of space to describe them properly, and they introduce no new principle.

The Reflection of Light. And now we reach a more difficult inquiry. We shall be able to elucidate some of the laws of the reflection of light, or, at any rate, to define them. But we must not be confused into thinking thereafter that we have really arrived at a complete knowledge of the subject; for observe the complication that is introduced. We are discussing, not light in itself, but the relation between light and material bodies. Since all our views as to the structure of matter are in the melting-pot, it is evident that, though we may be able to use terms and define them, we are very far indeed from being able to explain the facts which they indicate. Take such terms as *transparent*, *translucent*, and *opaque*. We know what is meant by the first, though the ideally transparent substance has yet to be found. A lens of glass or the transparent structure at the front of the eye will let through by far the greater part of the light that falls upon it, yet some light is always thrown back or reflected, and in so far the lens is opaque.

The terms are relative. A substance which is translucent occupies an intermediate place, but obviously there is no hard and fast line to be drawn between ground glass and the glass of our window-panes. The difference between the transparent and the translucent glass is this, that the light passes through the first without being distorted or scattered, whereas the translucent body allows the light, or most of the light, to pass through so that objects seen through it have their form proportionately distorted or entirely obliterated. Bodies are visible—for instance, a pane of glass is visible—exactly in so far as they are not transparent. If the pane be perfectly transparent—to approach which condition at all it is necessary that it be perfectly clean—it is necessarily invisible.

Light and Water. These terms will help us to return a simple answer to the question why water has different relations to light according as we look at the surface of an unbroken wave, or at the foam which is formed a moment later. The poet speaks of "Light dissolved in star showers thrown," but we must have a more scientific explanation. Foam is opaque, though merely consisting of water, and is incapable of reflecting the form of any object, simply because it contains a multitude of tiny bubbles. One result of this is that there is repeated and incessant reflection of the light that tries to pass through it, since a certain amount of light is always reflected when it passes from one medium to another, in this case alternately water, air, water, air—and so on. In the second place, the foam does not act as a mirror, because its many bubbles reflect the light in all directions, and so destroy the form of the waves that impinge upon them.

Now, in discussing heat, we saw that certain bodies are transparent to heat, or, to use the technical term, are *diathermanous*. We saw that diathermancy and transparency are not necessarily the same for any substance, the difference ultimately depending, of course, upon the fact that the waves of radiant heat are somewhat longer and less frequent than the waves of light.

Absorption of Light. But we also saw that radiant heat may be absorbed. If we compare water and bisulphide of carbon, of which the former is opaque to radiant heat, while the latter is *transparent*, we find that when these are respectively exposed to the action of radiant heat the water is heated, whereas the bisulphide is not. In other words, the heat has been absorbed by the water. This means, of course, that the energy is arrested, but is not destroyed. The law of the conservation of energy must be obeyed everywhere. Now, the case is exactly the same with light. A body may let light energy through it, or it may throw back the light energy from its surface, or it may do neither. It may arrest the light energy and keep it. Now, of this we are absolutely certain, that the light energy is not destroyed. What becomes of it, then? We find that the body is heated. It is simply a case of the transformation of energy, the light energy being converted into heat energy. It is also a case of the degradation of energy or the dissipation of energy, heat being the lowest, least available, form of energy, and that to which all other forms, as we have seen, appear consistently to tend.

Continued

DRESSMAKERS. A Sphere for Women. Starting in Business. Equipment. The Assisting Staff. Customers

ELECTRIC DEALERS. The Commercial and the Practical Sides. Varieties of Tradesmen. Buying and Estimating. Profits.

Continued from page 2225

DRESSMAKERS

Although at the present day the field of commercial enterprise offers many and varied opportunities to the woman who is desirous of earning her living—and practically any form of employment is open to her—still, with few exceptions, women workers have confined themselves to the various businesses in which they participate with their own hands, such as dressmaking, millinery, cookery, and laundry-work, in preference to those occupations where organisation and direction only are required, and the great majority of them have achieved success as dressmakers. The past twenty years or so have also witnessed the entry of society women into the commercial world, and in most cases they have proved themselves capable and efficient. It is one of the signs of the times that an aptitude for business, and the capacity for success in trade, should no longer be looked upon as evidences of plebeian origin and the peculiar attributes of the middle or lower classes, but are now envied qualities in many clever, hard-working women of good birth and recognised social position, who have elected to turn those talents to account in the domain of dress or millinery.

Classes of Dressmakers. The term "dressmaker" includes all sorts and conditions of women, from the wealthy Court dressmaker of Portman Square or Mayfair to the poor workwoman "plying her needle and thread" in the top room of a tenement house. They may, roughly speaking, be divided into three classes. First, those who have received little practical training, but have acquired a business by purchase, and employ subordinates to carry out their instructions and do the work for them; secondly, women who have been thoroughly trained, either by apprenticeship or special arrangement, and who have set up and formed a connection for themselves; and, thirdly, dressmakers who do not start an independent business of their own, but obtain employment with other dressmakers, or in the costume department of one of the large drapery houses.

Starting in Business. To start a high-class dressmaking business in London, it would be necessary to have at least £1,000 capital, especially if the locality chosen be in a West End neighbourhood, as such a position would entail high rent; and a fashionable dressmaker in town is always supposed to give three months' credit, and is frequently obliged to give six months. It would be unwise for anyone to start for herself without having at least three years' experience with a good firm. She should be an accurate cutter and fitter, possessing the artistic faculty to some extent, and having a correct eye for colour; should have a practical knowledge of trimmings, laces, etc.; and thoroughly understand the intricacies of buying and selling, the preparation of estimates, and all the details necessary to the successful management of a business. The stock kept need not be large, but must be well chosen and varied. An introduction should be obtained to a good wholesale firm, who would supply books of patterns of all goods, and send any lengths required on receipt of orders. Quarterly accounts are sent in, but when good references are given the wholesale houses often take half-yearly payments. A good system of bookkeeping is most important. If the head of the establishment should not be well qualified in this respect, a competent bookkeeper might come once a week or so until increase of work would necessitate the engagement of a permanent bookkeeper and stock-keeper combined.

Equipment. To set up in a provincial town, or in the suburbs, a smaller capital would suffice, as rents would be considerably lower, and wages to the workers not so high, while the clientèle would probably include a number of ready-money customers. To begin in a small way, it would be possible to manage with two good-sized rooms, one for a work-room and one for a show-room. A small room for fitting would be desirable, but if this should not be attainable part of the show-room could be screened off for the purpose. A treadle sewing machine (Jones' or some other approved pattern), two dress stands (one small and one a fairly large size), a tailor's goose, irons, a skirt-board, two tables (one for the workers and one for cutting out), together with a large cupboard for hanging up the work are a few of the things necessary for the work-room. In the show-room there must be a long glass, a couple of cupboards or a number of deep shelves for keeping stock, a writing table, with account books, bill files, etc., and usually a kind of counter on which goods can be displayed, together with a good supply of fashion papers and magazines, including the best Paris and Vienna journals. Such things as bones, bone casing, hooks and eyes, cottons, machine silks, pins, and dress patterns must be bought in fairly large quantities at first, and a sufficient stock should always be kept in hand, as workers must never be kept waiting for small items of this kind.

Assistance. To begin with, one competent general hand, who can work at skirts and bodices, and who is a good machinist, should be engaged. Her wages to commence would be from 16s. to 18s. a week; and an apprentice, who would run errands and make herself generally useful, would be paid about 2s. a week at first. When a few orders come in another worker should be taken on, at about 8s. a week, to work under the first hand, and so on as the work increases.

Apprentices are usually taken at the age of 14 or 15 years. In a good house a premium is required. The apprenticeship period usually lasts two years, at the end of which a girl may be taken as improver for six months, or less if special quickness is shown. An improver is paid, on an average, 8s. weekly. She will then obtain a position as assistant, at from 8s. to 16s. a week. From this her advancement will be rapid or otherwise, according to her individual capability and industry. There are always well-paid posts to be had by the skilful and well-qualified workers. Of these, one of the most desirable in many ways is the position of head fitter in the dressmaking department of one of the large drapers. Only an expert is chosen for such a post, and she is expected to make the department pay. She is usually given a free hand in the matter of engagement and management of workers; and in this connection it may be said that the most advantageous results are generally obtained from the assistants who are treated with the greatest consideration and kindness by their chiefs. A great deal very often depends upon getting out work within a given time, and this can best be done when the willing co-operation of the workers is secured, as, by the provisions of the Factory Acts, they cannot be compelled to stay beyond certain hours, yet they will often do so voluntarily, to oblige. Sometimes the fitter receives a commission on the work, and generally the salary paid to a satisfactory person is very good. An ambitious woman can frequently save enough money to enable her to start in business on her own account, where her prospects of success will be considerable, owing to her proved ability and her experience in dealing both with work and customers.

Women who have absolutely no means of obtaining any money to start with sometimes begin by taking work at their own homes. They only buy for immediate use, and are at once recouped by their customers so that they are not obliged to expend any money on materials. They often commence by making nurses' uniforms and servants' dresses, and in time some of them manage to build up a very fair business entirely through their own exertions.

Customers. Friends will probably form the earliest clients. They will come at first from friendship, or from curiosity, but if they are pleased with the work done, and if their orders are always executed with promptitude, they will continue to give their custom, and will tell their friends to come also, and so help to establish a connection. Sometimes a good method of securing business is to mention on the cards or notices sent out upon starting that ladies' own materials will be made up, and that *renovations* will be undertaken at moderate charges. This will often gain a fresh customer, as many people who might hesitate about entrusting an unknown dressmaker with a new frock would be very glad to try her capabilities in renovating an old one, and will then give further orders if the work is satisfactory. When the connection grows large it will be easy to give up the renovations, or, if they are found profitable, a separate department might be opened for this branch of work.

Some Hints. January, February, August, September, and sometimes October, are bad months. In slack times odds and ends of silk, lace, and net can be made up into little jabots, sleevelets, waistcoats, etc., and, provided that they are chic and up-to-date, will find a ready sale in the show-room if the prices are kept low. At the end of the first year it will be easy to see which customers may be trusted to run up bills, and which of them it would be wiser to be always "too busy" to work for. As the business increases a certain amount of selection can be exercised in the choice of customers, and those who are troublesome and fidgety, or who are bad at paying, can be struck off the books. Dressmakers living in the provinces should make a rule of coming to London at least three times a year, and, if possible, pay an annual visit to Paris.

ELECTRIC DEALERS

The man who makes electrical fittings his speciality must be more of a mechanic than a merchant; but the shopkeeping side of the business is not altogether lost to view in the more important departments, and a review of the shopkeeping trades would be incomplete without a brief consideration of the requirements and opportunities offered by the field of domestic and industrial electricity to the mechanic with scientific bent and average intelligence. The technical training of the electrical engineer is considered in another part of the SELF-EDUCATOR.

Departments. The two departments of the business are the *selling* and the *working* sides, and both again are divided into many varieties of work, from the simple electric bell to the complete installation of a complete generating plant. The order in which the classes of work come—from the simplest to the most complex—are bells, telephones, and the installation of lighting and power work. The degree of technical skill and the amount of capital required by the man who would set up as an electrical engineer are proportionate to the departments he intends to exploit.

Bell and Telephone Work. Let us take the simplest case first—the man who is engaged in one of the lighter mechanical trades, say that of a plumber, gasfitter, bellhanger, blacksmith, tinsmith, or cycle agent, and who would expand into electrical work. He would probably content himself with undertaking

electric bell and simple telephone work. His technical knowledge need not be extensive, and his capital, applicable to this department, may be very small. A few hand tools, the majority of which he will probably possess already, a few coils of insulated wire, some bells, pushes and batteries, and he is practically ready to invite custom. The whole outlay need not exceed £10, and half of this might even suffice. The principles governing bell work are simple, and may be learned by a few hours' study and by a few half-hours of practical experiment.

A higher step is reached when the man is able to undertake complicated telephone work such as intercommunication and switchboard system.

Wiremen. Then, in most towns where current is available there are many firms who occupy, in a different sphere, positions on the same plane as the gasfitter. They fit up houses with wires and electric light fittings, making all the necessary connections with the service mains, but take no part in installing plant to produce electricity or in making or repairing such plant.

For this class of work practical experience is almost essential. A good knowledge of theory may serve, however, if the man have considerable mechanical skill, and many electricians have begun in this way; but the probabilities of success without the practical training are now smaller than they were when the trade was in its infancy, and when fewer practically trained men were engaged in the work. The man must have a smattering of several trades. He must be something of a joiner to be able to lead his wood casing properly and neatly, he must be adept at pipe fitting for his metal conduits, and he must have an intimate general knowledge of the construction of houses, so that he may run his wires as accessibly, economically, and efficiently as possible.

The Electrical Engineer. Finally, there is the man or firm who combines with special electrical knowledge the skill of a mechanical engineer and who undertakes all varieties of installation and repair work, and may even do a little manufacturing on occasion. This man requires a proper workshop equipment similar to that of a mechanical engineer. He must have, say, a small turning lathe, a vertical drilling machine, a small planing machine, and a polishing plant, involving an outlay of about £80, not including a power engine—steam, gas, oil or electric—depending in nature and cost upon local conditions.

Essential Qualities. The installing of electric work requires care in a supreme degree. An installation contains many independent pieces of complicated mechanism. It may be easily put right if slightly deranged, but it is easily put out of gear. A screw become loose by vibration may hold up a large factory. Precision in the material and its fitting is essential. Hence, the man capable of this precision is alone likely to be a successful electrical engineer.

Conscientious work is as essential as precision. There is plenty of opportunity to scamp the work—more than formerly. The wiring of old buildings had to be chiefly surface work, which is, in spite of all that may be said, the better in that the wires are more accessible to inspection. But when new buildings are to be fitted with electric installations the work is largely concealed, and an unscrupulous wireman may save a little time and money by carelessness. But this is sure to come back to his hurt, and a man with a reputation for bad work might as well shut up and begin a clean slate elsewhere.

The Pure Merchant Side. The pure merchant side of the business of an engineer represents a very small part of his interests, and there is very little scope for the man who can take up only the selling department. For this side practical knowledge of electrical science is not essential, any more than a knowledge of tailoring is essential to a draper. Electrical engineers find that the pure sales department is a very small item in their business. The profits it yields are seldom more than pay shop rent, and most of them would discard it altogether if it were not for the indirect profit which follows. The possession of a shop and of a sign bearing the words "electrical engineer" or "electrician" serves to keep the man before the public eye, and this is most important for a new man pleased at first to undertake small contracts. The competition by many municipalities and electric lighting corporations in supplying consumers with lamps and electric fittings, and even in offering wiring, subject only to one annual rent charge, restricts the opportunity of private venture. The electrical departments of municipalities frequently sell fittings at cost price, relying for profits upon the consumption of current. This form of competition is particularly obnoxious to the private trader, and is a standing grievance in many districts. The practice has, however, become too firmly rooted to be suppressed, and probability is all in the direction of its expansion.

The Stock. The nature of the stock for the merchant side must depend upon the extent to which the supply companies in the neighbourhood—municipal and otherwise—cut into the trade and the policy they pursue. Assuming that the field is fairly free from this form of competition, the stock will consist of electroliers and fittings, switches, lamps and their fittings, telephones and their accessories, and bells and their oddments. An expenditure of £200 will purchase a good all-round equipment for a middle-class trade, and half of this sum may suffice for a modest start. The sum will depend upon the variety of the more expensive stock held. Electroliers, for instance, cost a deal of money, and half a dozen good examples will make a large hole in the capital. When the electrical merchant or engineer is in or near a city, he may spare himself some capital outlay by arranging to have his customers visit the show-rooms of the manufacturers or large factoring houses who

hold a variety to which he cannot aspire, and who are always willing to sell for him and to reserve to him his legitimate profit.

Buying. Extreme caution is necessary in the purchase of stock. Cheapness usually means nastiness and trouble laid up for the future. In incandescent lamps, for instance, while good varieties, such as the Ediswan, Sterne, and Robertson, will give satisfaction and help to make a reputation for their sellers, cheaper varieties, which may even pay better, may either estrange customers, or bring them back with a demand for free replacement.

Novelties, also, should be received with suspicion. There is in the electrical trade the same demand for novelties and improvement that prevails everywhere, but there is this difference—that electricity, being a comparatively new science, and not yet understood so well as the mechanical sciences, is the field of experiment as no other is, and much experiment means many failures.

Where to Buy. The beginner will find it convenient to patronise the houses who supply everything from a bell push to a dynamo, and there are several such. The practice makes only one account, and by having one good account a man is more likely to have good attention than when he has a multiplicity of small ones. Also he is more likely to receive consideration should he find himself in a technical difficulty and ask advice thereon. But as he grows in importance the dealer or electrical engineer will find that he can do better for himself by purchasing dynamos from dynamo makers, transformers from their manufacturers, lamps and telephones from the respective factories where they are made instead of from the general wholesalers with the "needle to an anchor" variety.

Profits. A frequent discount by makers and factors is 33⅓ from list price with an extra 2½ per cent. for monthly payments. To the casual buyer there will be no cutting unless the seller be foolish. There is no occasion for it. But to large buyers and regular customers list prices can seldom be maintained.

The bulk of the business will probably be found to be a matter of quotation, and certain commercial principles should guide the casting up of an estimate. It should be recognised that goods taken from stock ought to carry a heavier profit than articles which may be ordered on direct from the manufacturer to the "job."

Labour, again, should carry a higher profit than either of the two classes of goods mentioned. A fair average profit to apply to the three departments of a working job are as follows:

Goods taken from stock, 25 per cent.

Goods got in direct for the job, 15 per cent.

Labour, 33⅓ per cent.

These rates of profit are satisfactory, but by no means exorbitant. The electrician who goes below these rates as a general practice may make a living at his business, but he will scarcely gain a competency.

The rates we have given take no account of the uncertain "contingencies" which arise in every job. In exact calculation there should be nothing under this head in the materials required. It ought to be possible to include in any new work all material to the last screw and nail. But with time it is otherwise, and the estimate of time should always be liberal if the probability of loss would be avoided, and the profit on labour should be added after the liberal time estimate has been made.

Rules to be Followed. There are certain defined rules which the electrician in any district must follow in his practice. These are framed upon the requirements of public safety. They are seldom onerous and must always be known. There are the requirements of the fire insurance companies, who will accept a policy upon a building containing an electrical installation only if the equipment has been made in accordance with their rules.

The regulations of the Phœnix Fire Office are frequently taken as the standard.

Then each corporation or other electrical service company issues regulations to which any building electrically equipped must conform before they will permit connections to be made with their service mains, and the electrician must ascertain what these are in his individual district. The requirements of the Board of Trade are incorporated in the rules issued by the assurance companies and the supplying companies or corporations.

Reference Works. Every electrician must provide himself with some textbooks to guide him in his practice. The technical handbooks on electricity are legion and we cannot attempt to enumerate more than very few here. For a general concise survey of the principles of electricity and of electrical engineering practice, nothing better than the course on Electricity by Professor Silvanus P. Thompson in this work can be consulted. The most exhaustive and up-to-date authority covering the whole field of the generation of electricity and its industrial uses is the work in five volumes, "Electrical Installations," by Rankin Kennedy, C.E., published by the Caxton Publishing Co. Good books upon various departments are: "Dynamo-electric Machinery," by Silvanus P. Thompson (Spon), 2 vols., 30s. each. "Central Stations," by C. H. Wordingham (Griffin & Co.), 24s. "Primary Batteries," by Cooper (Electrician Co.), 10s. 6d. "Continuous Current Dynamos and Motors," by W. R. Kelsey (Technical Publishing Co.). "Practical Electric-wiring for Lighting Installations," by Charles C. Metcalfe (Harper), 5s. "Practical Electric Bell Fitting," by F. C. Allsop (Spon), 3s. 6d. "Telephones: Their Construction and Fitting" (Spon), 3s. 6d. "Electric Lighting and Power Distribution," by W. Perrin Maycock (Whittaker), vol. 1, 6s., vol. 2, 7s. 6d. "Electric-wiring Tables," by W. Perrin Maycock (Whittaker), 3s. 6d. "Electric Wiring," by W. C. Clinton, B.Sc. (Murray), 1s. 6d. "Modern Lightning Conductors," by Killingworth Hedges (Crosby Lockwood), 6s. 6d.

Continued

SPINNING TEXTILE YARNS

Spinning Machines: The Throstle, Cap Frame, Ring Spinning Frame, and Mule. Production of Cotton, Woollen, Worsted, Waste Silk, Linen, Rope, and Jute Yarns

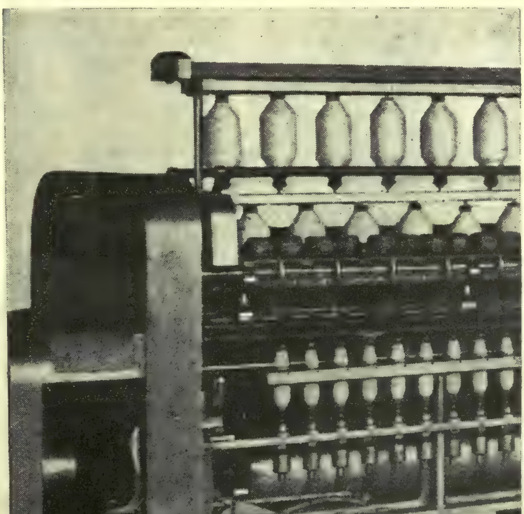
Continued from page 2293

By W. S. MURPHY

Spinning Machinery. Essentially, the whole process of forming fibres into yarn is spinning; but the work has been broken up into parts, and each division has been given a different name, the general term being reserved for the last of the series. As now understood, the spinning frame is the machine which finally draws, twists, and spools the yarn. It is important to note that there are three acts in the operation. Those acts may be performed simultaneously or successively, and the alternatives mark the difference between the two classes of spinning frames in use.

Abstractly, we should say that the machine which performs the whole operation at once is the better; but in actual fact the machine which proceeds automatically from the one act to the other is universally admitted to be the superior. Arkwright's water frame and Crompton's mule were the progenitors of the two opposed types. The strenuous organiser of the cotton factory aimed at producing a machine which would spin and spool the fibre in one operation. On the other hand, the gentle Crompton was content to accomplish the purpose in three successive steps. The present-day representative of Arkwright's contrivance is the *throstle* spinning-frame, of which we have several varieties. Crompton's mule is still the "mule," but it has been improved beyond recognition.

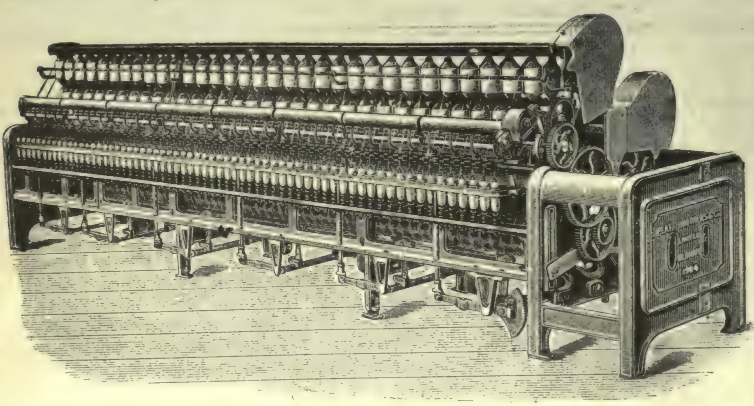
Throstle. This frame [89] is upright, and in three divisions. On the top are the fixed spindles which hold the bobbins of rovings, collectively called the *creel*. Midway we find the drawing rollers, similar to those on the drawing frames, but finer and swifter. The third tier is composed of spindle and flyer, bobbins and lifter plate. Note, however, that bands from a horizontal cylinder run through the whorls on the spindles only, and that no drive is carried to the bobbins. From the creel above the rovings pass down through the drawing rollers, and the attenuated thread is coiled round the leg and on to the hook of the flyer. Next it is lapped round the bobbin by hand to give it grip, and then the work begins. We see that the flyer is attached to the bobbin by the yarn, and if that were all, the bobbin would be bound to follow the flyer. But the yarn which is the cord of attachment is being given out from the drawing rollers. In order to keep up with the flyer, the bobbin must wind on the amount of slack constantly being paid out from the rollers and through the hook of the flyer. Of course, having no motion of its own, the bobbin must obey the combined rule of the roving and the flyer, and wind itself full. A traverse lifter-rail conducts the yarn evenly on the bobbin, moving up and down in regular motion across the whole frame.



89. THROSTLE SPINNING FRAME
(H. Bannerman & Sons, Manchester)

Cap, or Tube Frame. Originally the patent of an American named Danforth, the cap frame was patented and improved in this country by Mr. J. C. Dyer, of Manchester, in 1825. Instead of the flyer, this machine has a cap fixed on the spindle, the cap acting like a lever on the bobbin, which has its own driving gear. The tube frame is an early example of the daring genius of the American mechanic; where the steady British inventive imagination depends only on steel or iron for action, the Transatlantic contriver trusts to intangible force. From the drawing rollers the thread is fastened on to the bobbin, which, having a motion of its own, draws the thread with it. But this would never form a spool. It is here the characteristic genius

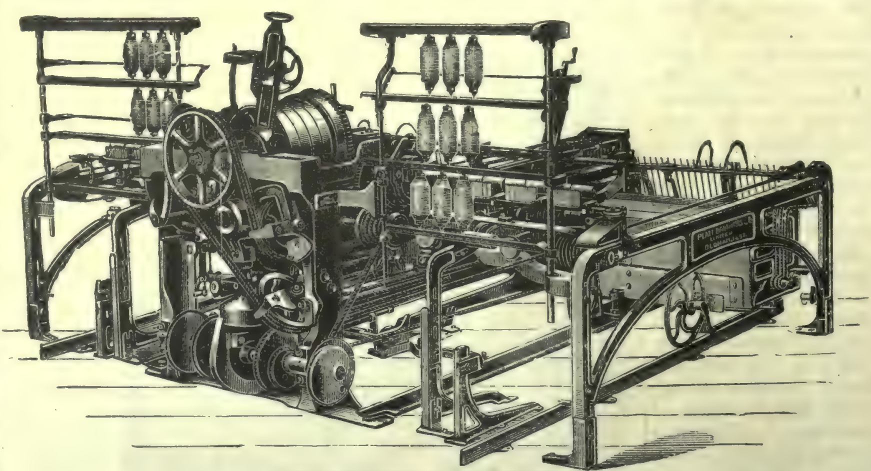
of the American appears. The cap is being driven at high speed, and it encloses both bobbin and thread. By the motion of the cap a centrifugal force is developed which winds on the thread, and the cap, moving up and down on the bobbin, distributes the yarn as evenly as possible all over the spool. A gradual reduction of the traverse of the cap produces the sloped ends, which are much favoured on all bobbins.



90. RING SPINNING FRAME (Platt Bros. & Co., Oldham)

Ring Traveller. The simple and rather haphazard winding method of the throstle was further improved upon by the invention of the ring traveller. Otherwise the construction of the frame [**90**] is unaltered. The various parts are distributed in this way. The bobbin sits on the spindle, which passes through the bolster rail, and is driven in the usual way. On the lifter rail, however, we find a ring with flanged rims, and within the rim a little hoop of steel grips with hook ends. The ring is wide enough to let a full bobbin through, and the hoop, or traveller, slides easily on the ring. When brought down from the guide eye the thread is passed through the hoop, and thence on to the bobbin. When the bobbin begins to whirl round, it cannot drag the thread round itself, except at such a rate as the ring traveller will permit. The drag of the little hoop is not great, but it is sufficient, and the revolving motion of the latter imparts a twist to the thread. Besides giving the thread the twist required, the traveller has another function to perform. Borne on the lifter rail, which moves up and down over the length of the bobbin, the traveller carries the thread in such a way as to distribute it evenly over the bobbin [**93**]. The ring spinning frame [**90**] shows double rail, patent flexible spindles, inclined roller stand, and the Birkenhead creel.

The Mule. Having been public property for over a hundred years, the spinning mule has been brought to a high pitch of perfection. Machinists, unable to patent any one of the principles, have been compelled to fall back on the expedient of producing the highest class of machine. As a result we have what has been described as the finest mechanism ever invented by the wit of man. In regard to the mule itself it is not necessary that the student should become acquainted with the various and intricate mechanical details. To exhibit these properly, we would require to explain several complex mechanical problems, and show many diagrams, while at the same time adding but little to the student's knowledge of cotton spinning. The headstock, in which the whole of the mechanical parts reside, is not the concern of the spinner so much as the engineer. Our business is with the spinning frames.



91. SELF-ACTING COTTON MULE—RUN AT BACK (Platt Bros. & Co., Oldham)

Working the Mule. First, we note the working of the self-acting mule [**91**]. The rovings are placed on the creel at the back

of the upright, stationary part of the mule. Led through the guide wires, the threads are passed in between three pairs of rollers, and on to a range of bare spindles. Before we examine the spindles, we should pay close attention to the drawing rollers. Closely resembling the drawing rollers of the drawing frame, the mule rollers have special features of their own. The first pair merely grip on the thread and feed it to the second pair. This is necessary, because the roving bobbins have no power of resisting the draft. The second pair move more swiftly, but not more than is needed to hold the threads tight and draw them slightly; the third pair revolve at a much higher speed, attenuating the threads, and feeding them to the spindles.

92. WEFT YARN SPUN

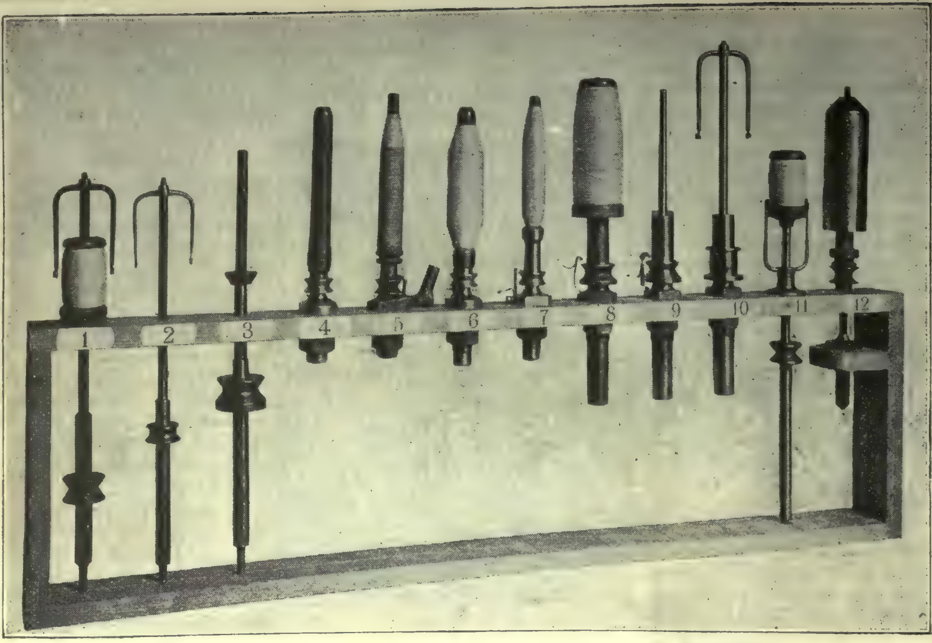
Note, further, that all these rollers have the power of stopping as soon as a certain fixed amount of thread has been given off. The reason for most of these particulars is to be found in what we may describe as the other half of the mule. This is a carriage borne on wheels running on rails. The average run of the carriage—the stretch, as it is called—is 64 in. in the case of cotton, and a few inches less for wool. On the top of the carriage, leaning slightly towards the frame, sit the spindles which take on the yarn as it is delivered from the rollers. Starting from close up to the frame, the carriage bears the spindles away, taking up the yarn, and stretching it across the widening space. Just before the limit of the run, or stretch, has been reached, the rollers stop and cease to deliver thread, the carriage slows, and the spindles rapidly revolve, twisting the thread. The whole machine stops for the fraction of a second, and the spindles perform a kind of reverse movement, unwinding the threads that have got wound on the tops of the spindles. At this moment a faller wire comes up, and helps the threads to lift off the points of the spindles. This done, the carriage begins its return journey at double speed, the spindles reversing their movement and winding on the threads, while another faller wire comes down to press down the threads and send them on to the body of the spindles, so as to form a regular cop.

Spindles. Every spinning machine, slubbing, intermediate and roving frames, throstle, ring spinning frame, cap frame, and mule has its own special spindle. In 94 we have an assembly of the chief types of spindle, arranged in something like the order of their development, though not exactly. There is a special feature in the "Rabbeth" to which attention must be given. In an ordinary spindle, by capillary attraction, the oil which lubricates the spindle is drawn up, and stains the bobbin and the yarn; to obviate this the "Rabbeth" has been devised. In No. 10 of the figure the structure is most obvious; there we see the sleeve with its hollow cup round the spindle. The bobbin sits on the rim of the sleeve, which takes in all the oil, and by its hollow shape tends to preserve the lubricant. No. 11 is another device directed to the same purpose. When we come to the doubling department, we shall see various forms of these spindles at work.

Spinning Cotton. It is very seldom that a cotton spinner meets with a throstle frame of the old model, and Danforth's cap frame has never obtained a strong footing in cotton mills. The honours are divided between the ring traveller and the mule. For the rapid, cheap production of low counts, the ring frame has no equal. In working with the traveller, it is important to note that the weight of the ring is exactly proportioned to the work. If too heavy, it breaks the yarn, which is unable to drag it round; if too light, the yarn will not be twisted, and the delivery is sure to be faulty. Oiling and cleanliness are specially to be attended to, for it is obvious that the least obstacle to a ring travelling at such a speed would be attended with serious results, and the constant friction would quickly heat both ring and traveller to fusing point.

Draft is a subject of general interest; but it is on the mule its most delicate issues are tried. To spin a thread which will give eighty-six miles to the pound calls for fine adjustment of the means, and this is what is done when we produce a 180 count [92]. There are even higher counts,

93. YARN FROM RING SPINNING FRAME



94. VARIOUS SPINDLES (Brooks & Doxey, Ltd., West Gorton, Manchester)
1. Flyer doubling spindle 2. Flyer spinning spindle 3. Plain ring doubling spindle 4. Self-contained ring spindle 5. "Mayor" ring spindle 6. "Union" gravity twist ring spindle 7. "Union" gravity weft ring spindle 8. "Ferguslie" ring doubling spindle 9. "Union" gravity ring doubling spindle 10. "Union" gravity flyer spinning or doubling spindle 11. Inverted flyer doubling spindle 12. Cap spindle

but these are generally produced by the hand mule and exceptionally skilled workers. We have seen the manner in which draft is put upon rollers, but the stretch of the mule carriage brings in another factor. You can use the carriage to attenuate the thread by simply making it run more quickly than the rollers deliver. In cottons of short staple this is risky; but with long-stapled cottons the practice is good, because by that means a fine twist is put on the threads, and all the soft parts are fully drawn, so that the final twist reduces the whole length to uniformity.

Spinning Wool. Woollen thread is taken directly from the condenser to the mule. But the action of this mule is quite different from the cotton mule. In the first place, there is only one set of drawing rollers on the woollen mule—one fluted roller paired with a heavy top roller—the chief use of which is to hold the yarn for the draft of the carriage. This brings out the second difference. The spindle carriage moves out, drawing the threads from the rollers, and when about half-way on its course the delivery ceases. Our carriage goes on its way, twisting and drawing out the yarn. At the end of the traverse or stretch the carriage stops, but the spindles continue to revolve, twisting up the thread. By a curious motion the yarn is let out for a few inches, to avoid hardening and breaking the thread. Now the spindles reverse, and the faller wires come into play, lifting off the loose threads from the head of the cop, and stenting the thread for the next act. The spindles stop, reverse, and then the carriage moves rapidly inwards, winding on the spindles the spun yarn.

Worsted. In worsted spinning any one of the three frames—the flyer, the cap, or the ring traveller—may be used. The latter has not come much into use, though some very tempting machines of that model are on the market. The throstle flyer is the favourite for general work, and specially for long-stapled wools. Only one thing is to be noted in worsted, as distinct from the general use of the flyer and spindle, and that is the amount of twist required. The flyer must be carefully adjusted by the change pinion, so that the required amount of turns may be given.

Spun Silk. Here we have a use for the old-fashioned throstle. The silk drawings are mounted on the creel of the throstle frame, and passed through drawing rollers and flyer on to the bobbin. Driven by a motion of its own, the bobbin pulls the thread round it, while the lifter plate and flyer regulate the delivery. No simpler, more direct method of spinning has been invented, and this strong staple suits it very well.

Linen Yarns. In linen manufacture we use the throstle spinning-frame, but with improvements and modifications which require special notice. Flax is a strong fibre, and in some ways rather intractable. An objection to the throstle by the cotton spinner is that it demands too much from the half-spun thread. A slender fibre like cotton could not be expected to carry round a bobbin and wind itself upon it by mere drag.

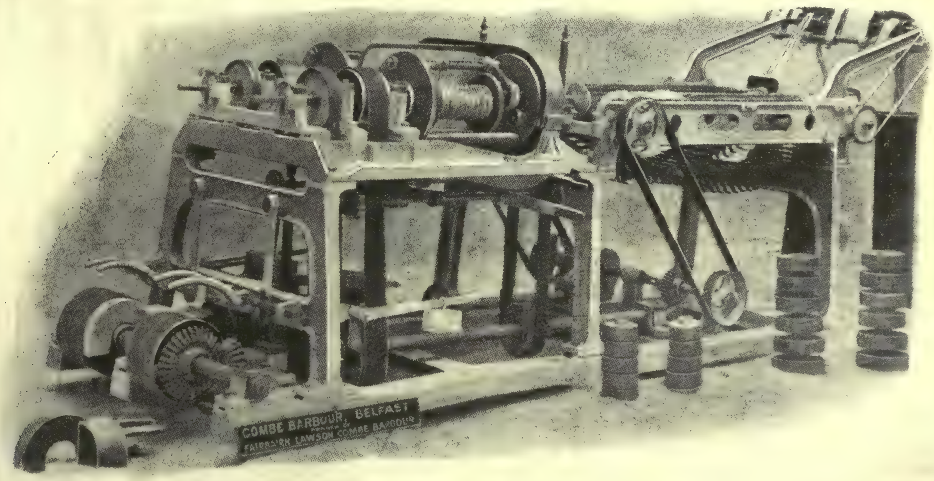
The difficulty with flax is all the other way. As the bobbins fill they develop a force of their own, and would soon overrun the supply of thread if nothing were done to prevent it. To meet this, a spring self-acting apparatus has been devised.

Along the traverse rail lies a long rod, with little steel springs attached, which apply a gentle and graduated pressure to the growing bobbins and keep them moving at a steady rate. The degree of pressure is very simply adjusted by means of the worm and ratchet wheel at the end of the machine.

Closely associated with this, and called into existence by the same cause, is the hot water trough. This trough sits in the middle of the machine, just below the creel on which the rovings are fixed. By the hot water the gummy substance of the flax is softened, and the fibre made amenable to spinning. From the trough the roving passes into the grip of the retaining rollers, the lower one brass and fluted, and the upper wood covered with felt or leather. Across the space known as the *reach* the threads are carried in between the drawing rollers, the speed of which is as much greater than the retaining rollers as the draft requires. When it has issued from the drawing rollers the thread begins to twist from the action of the flyers working on the spindles below the thread plate. Through the eye of the plate it is taken to the flyer, and on to the bobbin. It should, perhaps, be admitted that the patent self-acting drag of which we spoke has not come into universal use. The older method of dragging the bobbins by means of drag bands held against the bases of the bobbins by means of weights is still used. When the pressure has to be increased the spinner moves the weight a peg further away from the point of contact, and by widening the distance increases the leverage. The doffers, when the bobbins are filled, remove the flyers, break the threads, put on fresh bobbins, and the frame starts again.

Rope Yarns. The rope manufacturer has taken most of his machinery from the flax spinner; but he has made his own use of the appliances. It is very seldom you will find wet spinning in a rope factory. The softening of the fibres reduces their strength, and strength is the quality most desired in ropes. When water is resorted to, it is cold, and therefore does not melt the gum of the fibre to an injurious extent. For a long time the rope spinner was allowed to pick up his machinery where he would; but now the machinists have taken to considering his wants seriously. The consequence is that we have a good many machines on the market which have not stood the test for long use. As a rule, rope yarns are spun on horizontal spinning frames [95]. These frames have not yet been studied by us. Drawing rollers and spindle, with flyers, are all on one level. No new principle is involved, however, the chief recommendation of the horizontal form being the wider distribution of the weight of the frame.

Jute Spinning. The jute spinner uses a throstle spinning-frame, which is more elaborately mounted than any other textile spinner. The frame is of vast size, with bobbins, flyers, and rollers in proportion. The roving winds off the bobbin set on the creel on the head of the machine, and passes through the guide eye to the first pair of rollers, in through the binder plate, over the curved conductor plate, in between the drawing rollers, on through the thread plate, twining round the flyer leg, and on to the bobbin. As this is the only spinning frame proper of the jute worker, he must make the most of it, and it is no uncommon thing for a draft of 7 to 1 to be put on. Drawing out a thread with about one twist to the inch, and already drawn out to considerable tenuity, to such a length, involves some risk. For that reason we have a continuous succession of supports to the thread. The binder plate and conductor plate, before the drawing rollers, and the thread plate after, are necessary to support the yarn till it gets its final and strengthening twist from the flyer.



95. ROPE YARN SPINNER

Continued

continued from page 2229

STRESSES IN ROOF TRUSSES

Timber Trusses. Iron and Steel Trusses for Various Spans. Curved Trusses. Effect of Wind

By Professor HENRY ADAMS

Collar Beam Truss. This truss [187], although the simplest from a constructive point of view, is by no means simple when the stresses are considered. The legs of the truss tend to spread with the weight of the covering, and the part of the principal rafters below the collar is in the condition of a lever, so that if the walls are not rigid, a bending moment is produced at the junction with the collar. Modifications of this form are frequently used for the open roofs of churches, and the walls are only prevented from being thrust outwards by their dwarf height and the buttresses placed against them opposite to each truss. When the walls are higher, the overturning effort is greater, and many cases have occurred of the walls being actually thrust out. Under such conditions the collar beam is in full tension, but any intermediate condition may occur between this and full compression owing to rigid walls. It is this uncertainty of condition that creates the chief difficulty of estimating the stresses, but when allowance has to be made for the wind blowing on one side the difficulty is further increased. The frame and stress diagrams for vertical loading and rigid walls are shown in **188** and **189**, and for vertical loading and yielding walls in **190** and **191**. In **190** the bending moment diagram due to the leverage of the ends will be observed on the upper sides of the principal rafters. The dotted lines are virtual force lines to replace the bending moment diagram, and allow the complete stress diagram to be drawn.

King Post Truss. The king post truss [192] is the most common form for wooden roofs from 28 to 30 ft. span. The frame and stress diagrams with the wind on one side are shown in **193** and **194**. Upon a superficial view of **192** it appears as if the roof were supported by the king post standing on the tie beam, but the reverse is the case, as the tie beam is held up to the foot of the king post by an iron stirrup.

Composite Roofs. Composite roofs are formed of a combination of wood and iron, the compression members being of wood and the tension members of iron, which from its great tensile strength is more suitable, but these roofs are not very frequently adopted.

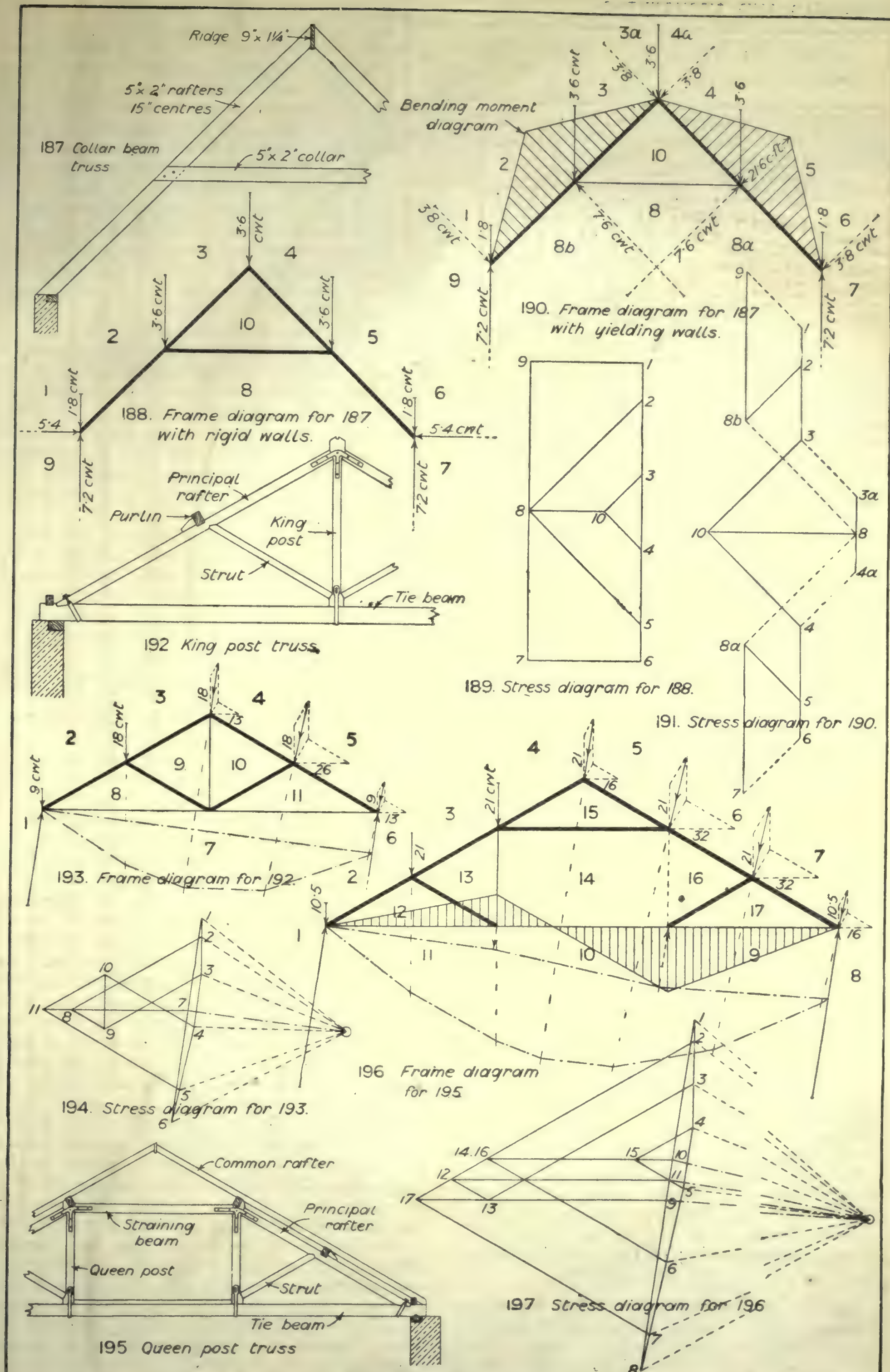
Queen Post Truss. The queen post truss [195] is a convenient form for wooden roofs of 30 to 45 ft. span. Under irregular loading, such as is produced by the wind acting upon one side, it is a deformable structure, owing to the want of cross bracing in the central space. Bending moments are caused in the tie beam, but its stiffness prevents the roof from suffering much actual change of shape. The frame diagram is shown in **196** and the stress diagram in **197**. As the latter involves some difficulty of construction, a full description will be given. First set down the load line 1 to 8 of stress diagram, join the extremities, which will give the direction of the reactions and substituted forces 1–11–10–9–8 on frame diagram without fixing the amounts. From point 2 draw an indefinite line parallel with 2–12 on frame diagram, and fix the position of point 27 upon it by a line from point 7 parallel to 7–17, then 17–9, being horizontal, will fix the position of point 9, thus obtaining the right-hand reaction. Next draw 4–15 and 5–15, giving point 15, and as points 15, 14, and 10 are all separated by parallel lines, the points will be on a straight line passing through point 15. This fixes the position of point 10, and at the same time the amount of substituted force 10–9, and as the substituted force farthest from the wind is equal to half the amount of the substituted force nearest to windward side, it will be seen that point 11 will be central between points 9 and 10. The remainder of the stress diagram présents no further difficulties, and after completion may be tested for accuracy by drawing a funicular polygon on the frame diagram as shown by stroke and dot lines, which will be found to close. The following tables of scantlings will be found suitable for ordinary cases, and will obviate the necessity for making calculations.

SCANTLING FOR KING POST TRUSSES
Baltic fir. 10 ft. apart. Pitch, 25° to 30°. Slated

Span Feet.	Thickness of Truss and all Members.	Breadth on Elevation.				Purlins.	Common Rafters.
		Tie Beam.	King Post.	Struts	Principal Rafters		
20	4	8	3	2	4	8 × 4	3½ × 2
22	4½	9	3½	2¼	4	8 × 4	4 × 2
24	5	10	3½	2½	4	8 × 4½	4 × 2
26	5½	11	4	2¾	4	9 × 4½	4½ × 2
28	6	12	4	3	4	9 × 5	4½ × 2
30	6½	13	4½	3¼	4½	9 × 6	5 × 2

Head and foot of king post twice width of middle. Reduce the thickness of truss by ½ in. and the depth of tie beam by 1 in. if there is no ceiling.

Wrought-iron and Steel Roofs. Omitting a few cast-iron ribbed roofs, it may be said that all metal roofs were formerly of wrought iron, but the greater tenacity of mild steel and its extensive manufacture render it *the* material of the present day. The same types of construction are used, the difference being only in the lighter sections employed. The arrangement of the trussing of all roofs varies primarily with the span; the roof covering is supported usually by "common rafters," and, in order that these may



187 Collar beam truss

188. Frame diagram for 187 with rigid walls.

189. Stress diagram for 188.

190. Frame diagram for 187 with yielding walls.

191. Stress diagram for 190.

192 King post truss.

193. Frame diagram for 192.

194. Stress diagram for 193.

195 Queen post truss

196 Frame diagram for 195

197 Stress diagram for 196

TIMBER ROOF TRUSSES

SCANTLING FOR QUEEN POST TRUSSES
Baltic fir. 10 ft. apart. Pitch, 25° to 30°. Slated

Span Feet.	Thickness of Truss and all Members.	Breadth on Elevation.					Purlins.	Common Rafters.
		Tie Beam.	Queen Post.	Struts	Principal Rafters.	Straining Beam.		
32	4	9	4	2	4½	6	8 × 4	3½ × 2
34	4½	10	4	2	5	6½	8 × 4	4 × 2
36	5	10½	4½	2	5½	7	8 × 4½	4 × 2
38	5½	11	4½	2	5½	7½	8 × 4½	4 × 2
40	5½	11½	5	2½	6	8	9 × 4½	4½ × 2
42	6	12	5	2½	6	8	9 × 4½	4½ × 2
44	6	12½	5½	2½	6½	8½	9 × 5	4½ × 2
46	6	13	6	2½	7	9	9 × 6	5 × 2

have economical dimensions, the purlins that carry them require to be within certain limits of spacing, say 5 to 10 ft. apart. This spacing fixes the position of the supports to the principal rafters, and therefore the number of bays into which they are divided. The distance apart of the trusses is partly determined by the strength of suitable purlins and partly by the desirability of securing a sufficient load upon each truss to obtain convenient and economical sections of the various members. Owing to the necessity of providing against the effects of corrosion, no bar or plate may be less than ¼ in. thick or ½ in. diameter, and where the load is very light, some material may be practically wasted from this cause. The external pitch of a roof is fixed by the nature of the covering and climatic or æsthetic conditions; the under side may be varied by giving more or less camber to the tie rods at pleasure, and this affords another means of adjusting the stresses in the members to an economical value, the stresses being increased as the camber is greater owing to the reduction of the central depth.

Number of Bays for Given Spans. The following table gives the average practice for iron and steel roofs, but so many points have to be considered in designing roofs that no precise rule can be laid down.

1 bay in rafter is suitable for roofs up to 15 ft. span.

2 bays in rafter are suitable for roofs 15 to 30 ft. span.

3 bays in rafter are suitable for roofs 25 to 50 ft. span.

4 bays in rafter are suitable for roofs 40 to 75 ft. span.

5 bays in rafter are suitable for roofs 60 to 100 ft. span.

Iron roofs to cover a large area are generally cheaper when the number of separate roofs is reduced and the trusses increased in span up to a maximum of 60 ft., owing to the more accurate proportioning of the material to the stress and the saving of supports.

Types of Construction for Various Spans. Typical arrangements of trusses with the principal rafters divided into one to four bays are shown in outline in **198** to **205**. With the exception of **205**, these involve no difficulty in determining the stress diagram and resultant stresses so that they need not be dealt with further; but the one referred to, known as a Fink, French, or Belgian truss or compound trussed rafter roof will well repay a more detailed investigation.

Fink Truss. Having drawn the frame diagram and marked on the external loads, set down the load line of stress diagram [**206**], join the extremities, and proceed with the diagram in the usual manner until point 14 is reached, when it will be found that point 15 cannot be obtained as only one of the surrounding spaces is known—*viz.*, 14, and it is at this point that the method of *substituted members* will have to be resorted to, in order to find point 18. For the members 15, 16, 17 on frame diagram substitute the member *a-b*, as shown for clearness on separate sketch [**207**], then, turning again to the stress diagram, draw 14-*a*, 4-*a*, giving point *a*; *a-b*, 5-*b*, giving point *b*; and *b*-18, 11-18, obtaining point 18. The remainder of the diagram may now be added without further difficulty.

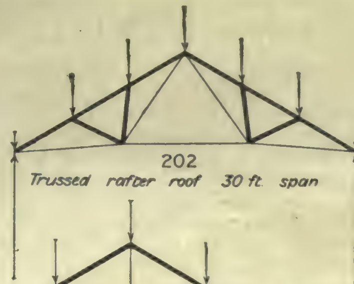
Curved Trusses. A crescent or sickle-shaped truss is sometimes used for large roofs, as in the case of the Charing Cross, Cannon Street, and Fenchurch Street railway-stations in London. In such cases it is necessary to provide cross bracing to allow for the effect of the wind on one side or the other, so that whichever side it blows from one member of the cross bracing in each bay will take the whole of the load as a tensile stress. The Charing Cross truss is shown in **208**.

Effect of Wind. It is not an easy matter to measure the velocity of the wind, and it is still more difficult to estimate its force against a plane surface in any position. Although consideration has been given to the subject for more than a hundred years there is still a need for practical investigation upon a large scale. It may, however, be assumed that in ordinary positions a pressure of 28 lb. (¼ cwt.) per square foot is very rarely exceeded, and that in the most exposed positions an allowance of 56 lb. (½ cwt.) per square foot will cover all contingencies. The larger the area taken into account at one time the lower the pressure is likely to be. It does not always blow horizontally, and when there are many buildings in the neighbourhood it may be deflected downwards upon any given roof. Assuming the wind to blow horizontally with a force of 42 lb. per square foot against a roof of 30 degrees pitch the effect normal to the roof plane [**209**] will be reduced to $p \sin \theta = 42 \times \sin 30° = 21$ lb. In the same way, if the wind be assumed to blow horizontally with a force of 56 lb. per square foot the normal pressure will be reduced to 28 lb. Authorities are, however, not agreed as to the true normal pressure, some take it as the $p \sin \theta$, others $p \sin^2\theta$, and still others as $p \sin \theta\ 1{\cdot}84 \cos \theta - 1$. These values are contrasted in the curves shown in **210**.

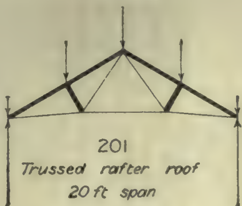
Continued

198
Roof truss for 15ft span

200 King rod roof truss 20 ft. span

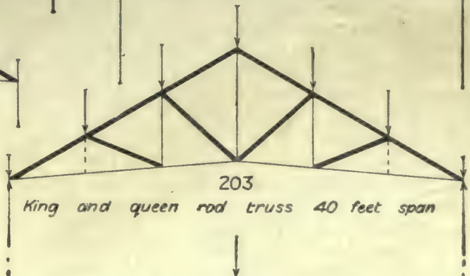


202
Trussed rafter roof 30 ft. span

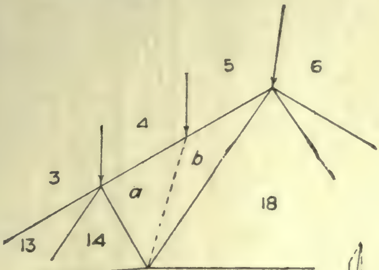


201
Trussed rafter roof 20 ft span

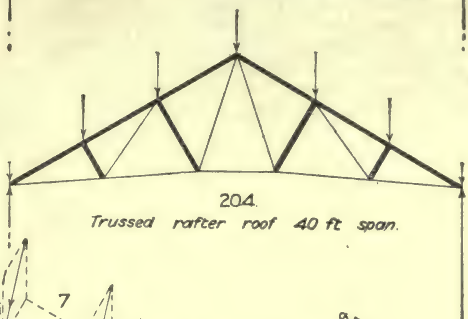
199
Roof truss for 15 ft. span.



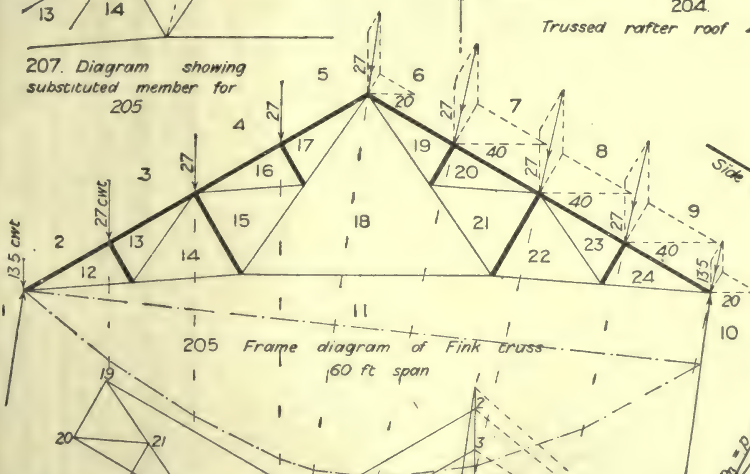
203
King and queen rod truss 40 feet span



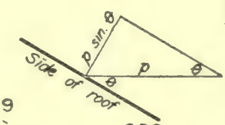
207. Diagram showing substituted member for 205



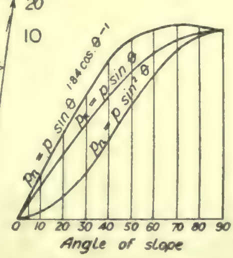
204.
Trussed rafter roof 40 ft span.



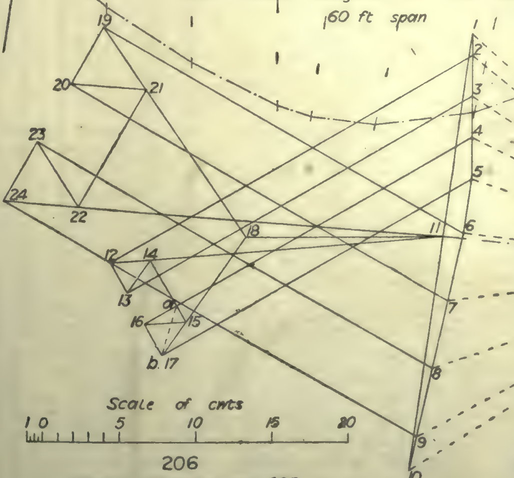
205 Frame diagram of Fink truss 60 ft span



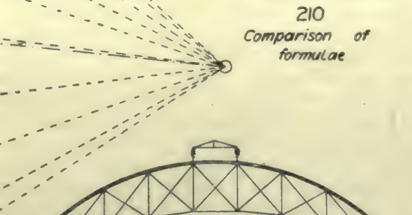
209
Effect of wind on roof



210
Comparison of formulae



206
Stress diagram for 205



208.
Charing Cross Railway Station roof truss

IRON ROOF TRUSSES

NINETEENTH CENTURY PROSE

2.—Being a Brief Review of the Essayists, Historians, and Philosophers, from William Cobbett to Thomas Carlyle

By J. A. HAMMERTON

The Characteristics of Cobbett. WILLIAM COBBETT (b. 1762; d. 1835) started life by scaring crows, but left a name which will be remembered with those of the most famous writers of his own time. He may be said to personify the whole art of self-education. By self-denial and perseverance he acquired a vast sum of varied knowledge, and wielded immense influence as a politician and a journalist, inspiring his countrymen with a reasoned love of their native land. Despite extraordinary difficulties, he learnt English and French so well as to be able to write grammars in both languages, and developed a literary style as natural as Defoe's, as vigorous as Swift's, brightened by humour and telling invective, and perhaps as characteristically Saxon as any that could be named. He was a clean-living man, who delighted in the open air, being a born student and lover of Mother Earth. Above all, Cobbett saw clearly, thought clearly, and uttered clearly. His varied career from plough to Parliament will well repay study. The works he left are as diversified as was his life.

Cobbett's "English Grammar" and "French Grammar" are written in the form of letters to his son, and are unsurpassed in the lucidity of their arrangement and their quality of genuine liveliness. We could wish that everyone read the former. Despite its unattractive title, it may be commended as vastly entertaining as well as instructive. His "Weekly Political Register," started in 1802, was continued, apart from one small break, until his death; it was for two years edited from prison, where he was sent for his strictures on flogging in the Army; and for a time from America, whither he fled to escape from further imprisonment. In 1803 he began the "Parliamentary Debates," whence originated our present "Hansard." He wrote a "History of the Reformation," which is still read, though chiefly by Roman Catholics; but his "Advice to Young Men" is full of practical common-sense for all. Every young man should read it, and young women also. Its vigour and frankness are as refreshing as the breath of the sea. His best work is to be found in the picturesque accounts of his political tours on horseback, which are familiar as "Cobbett's Rural Rides," and the student in search of a guide to muscular English would do better to read a chapter from this each day than from almost any other prose work. Of his faults, his egotism has counted too much to his detriment. That it was a reasoned egotism may be seen in a brief passage from the "Rural Rides."

A Specimen of Cobbett's Style. The writer remarks on the beneficial effects of early rising on the traveller, abstinence from wine and spirits, and moderation in eating, and on the fact that, under conditions specified, the riding of twenty miles was not so fatiguing at the end of a tour as the riding of ten miles was at the beginning of it. He goes on to say:

"Some ill-natured fools call this egotism. Why is it egotism? Getting upon a good strong horse, and riding about the country . . . requires neither talents nor virtues of any sort; but health is a very valuable thing; and, when a man has had the experience which I have had, in this instance, it is his duty to state to the world, and to his own countrymen and neighbours in particular, the happy effects of early rising, sobriety, abstinence, and a resolution to be active. It is his duty to do this; and it becomes imperatively his duty when he has seen, in the course of his life, so many men, so many men of excellent hearts and of good talents, rendered prematurely old, cut off ten or twenty years before their time, by a want of that early rising, sobriety, abstinence, and activity, from which he himself has derived so much benefit, and such inexpressible pleasure . . . It is seldom that rain, come when it would, has prevented me from performing the day's journey that I had laid out beforehand. And this is a very good rule: stick to your intention, whether it be attended by inconveniences or not; to look upon yourself as bound to do it."

Here we have Cobbett the man; no dreamy theorist, but a master of hard facts and a master who is compelled to convey his knowledge in a manner which none can misunderstand. Cobbett is not a great literary character; but his style is the best of models for all who aspire to write clearly and correctly, and he occupies by right a definite place in the pages of the SELF-EDUCATOR.

Anecdotes and the Minor Morals. ISAAC D'ISRAELI (b. 1766; d. 1848), the father of Lord Beaconsfield, wrote a number of anecdotal works which, though somewhat slipshod, offer evidence of much culture and wide reading, being chiefly notable for the entertainment they afford and the stimulus they give to further inquiry in the by-paths of literary history. The "Curiosities of Literature" is the best of these; its companions are "Calamities and Quarrels of Authors," "Amenities of Literature," and "The Literary Character." JOHN FOSTER (b. 1770; d. 1843), a Baptist minister, was the author of a series of "Essays," one of which, that "On Decision of Character," should be read with Cobbett's "Advice to Young Men"; the "Self-Culture" of JOHN STUART BLACKIE (b. 1809; d. 1895); and the "Self-Help" of SAMUEL SMILES (b. 1812; d. 1904).

Landor's "Imaginary Conversations." WALTER SAVAGE LANDOR (b. 1775; d. 1864) was an author who, as Mr. Birrell says, "preferred stately magnificence to chatty familiarity." He lived, in a sense, alone, and his work is also independent. Writing poetry for "amusement" and prose as "business," his "Imaginary Conversations" possess strong dramatic qualities which have caused many to wonder that their author failed to write a great play. Describing these "Conversations," the late H. J. Nicoll, in a brilliant passage of summary writing, says that they "are full of fine thought, expressed in a style so finished, so eloquent, so clearly bearing the impress of genius and cultivated taste, so felicitous in imagery and diction, that one wonders why they are in general so little read. The reason probably is that their subjects have little interest to people in general, and that their tone of sentiment does not, for the most part, appeal to the ordinary sympathies and emotions of humanity." The "Conversations" were published between 1824 and 1853; they range over a vast area of topics, and are 125 in number. In these lofty and earnest pages we are, says the "Edinburgh Review" of 1846, by turns, "in the high and goodly company of wits and men of letters; of churchmen, lawyers, and statesmen; of party-men, soldiers, and kings; of the most tender, delicate, and noble women; and of figures that seem this instant to have left for us the Agora [Greek equivalent of the Roman Forum] or the schools of Athens, the Forum, or the Senate of Rome. At one moment we have politicians discussing the deepest questions of state; at another, philosophers still more largely philosophising; poets talking of poetry; men of the world of worldy matters; Italians and French of their respective literatures and manners." Landor, in fine, is our English Lucian: that classic writer of dialogues who flourished in Greece during the second century. Among Landor's dialogues especially admired for their dramatic intensity are those between Peter the Great and Alexis, and Henry VIII. and Anne Boleyn. "I shall dine late," said Landor, in an oft-quoted phrase; "but the dining-room will be well-lighted, the guests few and select." Yet we may all some time or other "dine" with Landor as our host and be assured of excellent entertainment. When one is studying the life of Shakespeare, Landor's "Examination of William Shakespeare" may be read as a charming piece of imaginative prose.

Some Lesser Litterateurs. WILLIAM HONE (b. 1780; d. 1842) was a sort of minor Cobbett, with something of D'Israeli's feeling for letters. His "Every-Day Book," "Table-Book," and "Year-Book" bear tribute to his industrious study of old manners and customs. The first-named contains a tenderly-worded dedication to Charles Lamb, and to the "Table-Book" the "gentle Elia" contributed his selections from the Garrick Plays. But Hone's books are chiefly valuable as works of reference to the literary man. The "Papers" of JOHN WILSON CROKER (b. 1780; d. 1857) and THOMAS CREEVEY (b. 1768; d. 1838) supply much intimate detail of the Court, literary, and political life of their time, the one from a Tory and the other from a Whig point of view. Croker, who is much better known, Creevey having been a "discovery" of Sir Herbert Maxwell in 1903, was a frequent contributor to the "Quarterly Review." His chief work was an edition of Boswell which drew forth a remarkably bitter criticism from Macaulay, and he also began an edition of Pope which was completed in our own time by WHITWELL ELWIN (b. 1816; d. 1900) and Dr. W. J. COURTHOPE (b. 1842).

Leigh Hunt. JAMES HENRY LEIGH HUNT (b. 1784; d. 1859) was an essayist of considerable charm and versatility, whose friendships secure for him a greater meed of recognition than his writings, though these are not unimportant. He introduced Shelley and Keats to one another, and brought these poets before the public in the "Examiner," of which he was editor and part proprietor. The student of English literature will find much profit in his "Imagination and Fancy," "Wit and Humour," and "Men, Women, and Books." His "Dante's Divine Comedy: The Book and its Story" is also of value, while his "Autobiography" contains enough to secure for it the permanent interest of all bookmen. London and "The Cockney School" found in him an energetic champion, and his gossipy volume on "The Town: Its Remarkable Characters and Events" retains a certain measure of popularity. As a critic he was appreciative; and his method of handling such themes as old age and child life easily secures for him the affection of sympathetic readers. He had another link with Charles Lamb: he stammered. It was only in part—and that part a small one where his real worth is concerned—that he can be associated with Charles Dickens's satirical portraiture of Harold Skimpole in "Bleak House."

NASSAU WILLIAM SENIOR (b. 1790; d. 1864) was an acute literary critic as well as a political economist. His "Essays on Fiction," articles on Scott, Lytton, Thackeray, and others, contributed to the "Quarterly," "Edinburgh," and other reviews, were published in collected form in 1864, and will well bear perusal by the student. WILLIAM MAGINN (b. 1793; d. 1842), scholar, critic, humorist, was once a great force in the magazine world. He remains, despite all his great gifts, a "might-have-been," the original of the Charlie Shandon in Thackeray's "Pendennis." He was one of "Blackwood's" most brilliant contributors, and as the conductor of "Fraser's Magazine" he gathered round him some of the choicest and most distinguished of contemporary writers. ANNA BROWNELL JAMESON (b. 1794; d. 1860) wrote a volume on "The Characteristics of Shakespeare's Women," which is still a favourite.

A Short Study of Carlyle. THOMAS CARLYLE (b. 1795; d. 1881) began his literary career as a writer in the "Edinburgh Encyclopædia," for which, between 1820 and 1823, he wrote articles on Lady Mary Wortley Montagu, Montaigne, Montesquieu,

Dr. John Moore, Sir John Moore, Necker, Nelson, Mungo Park, Lord Chatham, William Pitt, and several papers of a topographical character. Only one of these—the paper on Sir John Moore—can be described as inadequate. From the first Carlyle seldom spared himself. In 1824 he published two translations—one from the French (Legendre's "Geometry"), and one from the German (Goethe's "Wilhelm Meister"). The latter work, praised by "Blackwood's" and the "Edinburgh," was attacked by De Quincey in the "London Magazine," to which Carlyle had been contributing his "Life of Schiller." The last chapters of the "Life of Schiller" appeared simultaneously with the unjustifiable attack. Whatever pain may have been caused by De Quincey was more than assuaged by the commendation from Goethe, who wrote a eulogistic introduction to a translation of the Schiller volume which was published at Frankfort in 1830, three years after Carlyle's period of apprenticeship may be said to have been brought to a close with his studies of "German Romance." Meanwhile Carlyle had met Jeffrey and become a contributor to the "Edinburgh Review," his connection with which lasted for seventeen years.

Carlyle's Literary Style. One of the real curiosities of literature is the distinction between the form of Carlyle's early writings and that known as "Carlylese," the undoubtedly powerful, but electrical, explosive, ejaculatory style whose beginning may be noted in his "Sartor Resartus," a work of autobiographical as well as of philosophical interest, which, originally published in "Fraser's," first won adequate recognition in America. The student who would read Carlyle aright can do no better than begin by digesting Professor Nichol's masterly monograph in the "English Men of Letters" series; Froude's contentious pages should be left for a later period. Carlyle's greatest works are those in history, sociology, and politics. But there is a great deal in his miscellaneous essays — those on Burns, Johnson, Scott, Voltaire, Diderot, and Mirabeau, for example—that must not be overlooked by any reader who desires to understand the man himself. Carlyle has been greatly misunderstood; but his influence has been almost incalculable in Germany as well as in England. He was "human, like ourselves"; more, perhaps, of an iconoclast and a prophet than a constructive power; but he looked to the "foundations of society," he had a genuine love of truth, and his striving after truth has left to posterity a standard of thought which must remain a permanent social as well as literary force.

The Influence of Carlyle. Essentially masculine in view, Carlyle has yet had a marked influence on women readers. The Swift of the nineteenth century, many a Stella has been his pupil. Appreciations—and depreciations—of his labours there are in abundance, but perhaps Walt Whitman in his "Specimen Days" touched the reality as closely as anyone. "As a representative author, a literary figure," he wrote, "no man else will bequeath to the future more significant hints of our stormy era, its fierce paradoxes, its din, and its struggling periods than Carlyle. He belongs to our own branch of the stock, too; neither Latin nor Greek, but altogether Gothic. Rugged, mountainous, volcanic, he was himself more a French Revolution than any of his volumes . . . As launching into the self-complacent atmosphere of our days a rasping, questioning, dislocating agitation and shock, is Carlyle's final value." Carlyle began life, in a sense, by teaching mathematics in a Fifeshire school; he remained a teacher to the end of the chapter. As a stylist he is the greatest "free lance" in the language; but the reader should beware lest he impute to the leader the sins of his would-be followers, as many a one has sought to thunder in Carlylian strain with the most unhappy results. Where Carlyle's style is concerned we must not judge him by the standard of any other writer; he claims by right to be judged by the vivid (and vivifying) result. Of no great writer could it be said with more cogency that "the style is the man." His view of the literary calling is indicated in his lecture on "The Hero as Man of Letters," where he writes:

Carlyle on the Man of Letters. "On the whole, one is weary of hearing about the omnipotence of money. . . . There ought to be Literary Men poor. . . . Who will say that a Johnson is not perhaps the better for being poor? It is needful for him, at all rates, to know that outward profit, that success of any kind is *not* the goal he has to aim at. Pride, vanity, ill-conditioned egoism of all sorts, are bred in his heart, as in every heart; need, above all, to be cast-out of his heart,—to be, with whatever pangs, torn-out of it, cast-forth from it, as a thing worthless. Byron, born rich and noble, made-out even less than Burns, poor and plebeian. Who knows but, in that same 'best possible organisation' as yet far off, Poverty may still enter as an important element? What if our Men of Letters, men setting-up to be Spiritual Heroes, were still *then*, as they now are, a kind of 'involuntary monastic order'; bound still to this same ugly Poverty,—till they had tried what was in it too, till they had learned to make it to do for them! Money, in truth, can do much, but it cannot do all. We must know the province of it and confine it there; and even spurn it back, when it wishes to get farther."

We cannot well in a few words arrive at any plan for the especial study of Carlyle. From the wide range of his writings the general reader will take to such works as his fancy prompts, the student to those his studies suggest, and both may be left safely to come under the all-compelling influence of this mighty and original thinker. The least that should be known of Carlyle's works are "The French Revolution," "Sartor Resartus," "Heroes and Hero Worship," and "The Life of John Sterling." If one begins with "Heroes and Hero Worship," the appetite is more likely to be whetted than by entering the Carlyle treasure-house through the gate of "The French Revolution."

Continued

PATTERN CONSTRUCTION & MOULDING

The Materials and Tools for Patterns. Pattern Making. Moulding Tools and Practice. Bedding-in. Turning over. Sweeping

continued from page 2342

By JOSEPH G. HORNER

We are now in a position to consider first the methods of pattern construction, and then the broad systems of moulding adopted.

The Pattern. The pattern must be considered from two principal points of view—that of its method of construction and maintenance of form (matters which it has in common with wood-working generally), and that of its moulding, or facility for delivery from the sand. It is the last named which separates pattern-making as a trade from carpentry and joinery.

The Materials. It is obvious that maintenance of form may be secured in one of two ways, either by employing a non-perishable material, or by adopting those strong methods of construction which are practised in the wood-working trades generally. Both are employed in pattern-making. Articles of small and moderate dimensions, from which hundreds or thousands of moulds have to be taken, are made in metal, while others—namely, those of large dimensions, and those of any sizes from which comparatively few castings are required—are constructed in wood. These last include by far the largest number.

Timber. Then, as there are different kinds of timber, some stronger and more durable, some less given to warp and shrink than others, selection is made from several sorts to suit different classes of patterns. Yellow pine and mahogany are chiefly used. Other woods are occasionally employed, but not to any considerable extent. Yellow pine is suitable for large patterns, mahogany for those of small size. Both woods must, of course, be well seasoned, and the straighter the grain and sounder the stuff the better. The choice of yellow pine as the principal material for pattern-making might seem to be objectionable on account of its softness and openness of grain, as being ill-adapted to stand the rough usage of the foundry and to resist the action of the moisture in the foundry sand.

But in patterns properly constructed these objections have little reality in fact, for they are protected from excessively rough usage by the insertion of rapping and lifting plates, and the porous grain is protected with varnish or paint. And, on the other hand, these possible evils are much more than counterbalanced by the advantages of moderate price, straightness of grain, workability, and fair capacity for resistance to heat and moisture. And, further, many patterns are moulded from only once, or a few times, and for these pine is amply good enough. For patterns which are to have a very large number of mouldings, and of not excessive dimensions, there is always the harder but more costly mahogany available.

Tools. Being a wood-working trade, the tools used are nearly identical with those employed by carpenters, joiners and others. The principal ones will be found illustrated in the series devoted to Carpentry and Joinery, while underlying principles of their design are treated in the series on Tools, so that only a bare list of pattern-makers' tools need be offered here. They are the following:

Saws. Hand, tenon, dovetail, bow, compass, and keyhole.

Planes. Jack, trying, smoothing, rebates, and rounds.

Chisels. Paring, $1\frac{1}{2}$, $1\frac{1}{4}$, 1, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{4}$ in.; firmer, $1\frac{1}{2}$, 1, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{4}$ in.

Gouges. Paring, flat, $1\frac{1}{2}$, 1, $\frac{3}{4}$ in.; middle-flat, $1\frac{1}{4}$, $\frac{3}{4}$ in.; quick, $1\frac{1}{4}$, 1, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{4}$ in.; firmer, $1\frac{1}{2}$, $1\frac{1}{4}$, 1, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$ in., to which may be added a few bent gouges for core-box work.

Turning Tools. Gouges, $\frac{3}{4}$, $\frac{3}{8}$, $\frac{1}{4}$ in.; chisels, $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{4}$ in.; side tools, right and left handed, $\frac{3}{4}$, $\frac{1}{2}$ in.; round noses, $\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{4}$ in.

Boring Tools. Brace and set of bits, half-dozen gimlets, half-dozen bradawls.

Measuring Tools. 2 ft. standard rule, 2 ft. iron contraction rule, 12 in. try-square, $4\frac{1}{2}$ in. try-square, two set-squares, bevel, two pairs of trammels, large and small; wing compasses and spring dividers, two small marking gauges, and a panel gauge. Two pairs of callipers, one inside, one outside.

Miscellaneous Tools. Hammers, light and heavy; wooden mallet, two screwdrivers (one large, one small), drawknife, axe, spokeshave, hone, two gouge slips. A somewhat smaller selection will suffice for a beginning. Many workmen will double the number. This is only a representative selection, and no more.

Machine Tools. The machine tools used in pattern shops embrace lathes, circular and band saws, planing machine, trimmers, and sometimes a special apparatus for the setting and sharpening of circular and band saws. So much of economical working necessarily depends on the employment of the machines that even in small shops employing only half-a-dozen hands these should find a place. There should be even in these two or three lathes, ranging in dimensions from 5 in. to 10 in. centres, one of which should properly be a face lathe, also a circular saw, either of the common type, or of the dimension kind, the latter being preferable where one saw-table only is used, a band-saw of light construction, with wheels

of not less than 2 ft. 6 in. diameter, the width of saws to range from ⅜ in. to 1 in., and one planing machine, being either a surfacing machine or a thicknessing machine, or both in combination. All these machines should be under the charge of one man, as increased efficiency is thereby obtained.

The Pattern : Its Permanence of Form. There are five principal methods by which permanence of form is secured in patterns,—open joints, boxing-up, halving, lagging-up, and segmental construction, each one being adopted in different classes of work, and two or more often being combined in one piece. Their necessity is due to the treatment to which patterns are subject, of moisture in the sand, and of dryness out of the sand and in the stores.

Open Joints. These fill a valuable place in pattern work. The necessity for their use occurs in wide pieces. If, for instance, a piece of board be 6 in. or 8 in. wide it cannot shrink or expand much under changeful hygrometric conditions. But if, say, 18 in. wide, or if a broad pattern of 3 ft. or 4 ft. in width be glued up like a table-top, its width will be constantly changing, according as it is in or out of the sand. These changes are minimised by using narrow strips with joints open to the extent of $\frac{1}{16}$ in. or $\frac{1}{8}$ in., in which space the movements of the boards are localised. Fig. **53** shows a broad plating with open joints. The separate pieces are often dowelled, and they are retained flat by the other parts of the pattern on which they are fastened.

Boxing-up. This is preferable to making large patterns of solid timber, for three reasons—first, because shrinkage is lessened; secondly, because timber is economised; and thirdly, because the weight is reduced. Patterns are boxed up by nailing or screwing top and bottom sides to cross bars [**53** and **54**]. There is a right and a wrong way of doing this. The right way is to carry the sides up, as in **53** and **54**. The wrong way is to bring top and bottom right across, as in **55**. The reason for this difference is that when the top or bottom shrink or swell they cause overlaps, which tear the sand up.

In wide, boxed-up patterns, the top and bottom are made with open joints [**53**].

Halvings. Halvings [**56**] fill a large place in pattern work, as they do in carpentry. But they are employed more frequently in the former trade, being adopted in most cases where tenoned and mortised joints would be made by the carpenter and joiner. They are more easily cut, and are substantially as serviceable for patterns, besides which they have the very great advantage of permitting subsequent alterations in patterns, which fill a large economical place in the trade.

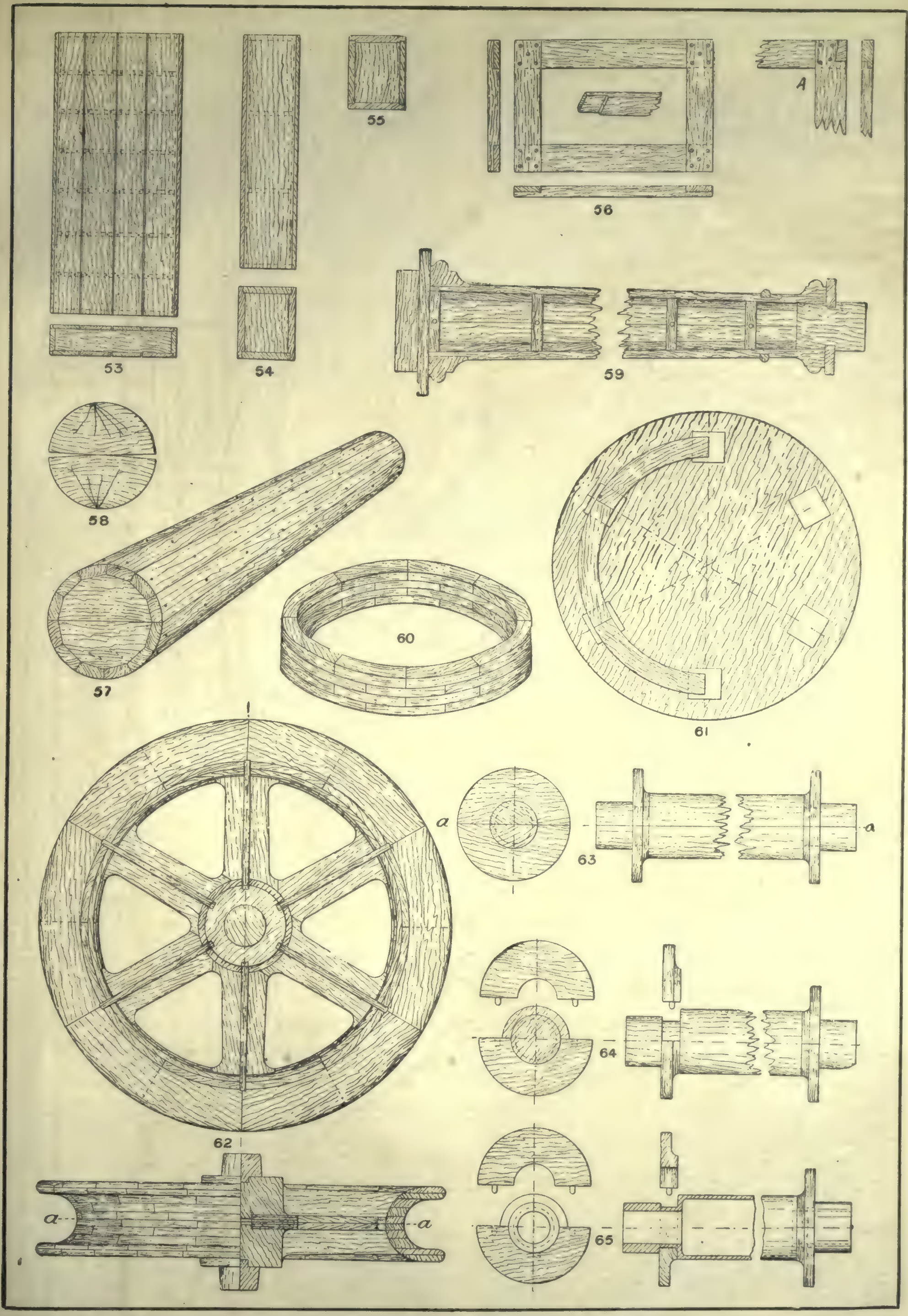
Halvings are adopted when framings have to be constructed for which the crude device of cutting out of solid board would involve short grain. A single example of a halved frame, typical of hundreds of variations in outline, is given in **56**. With the halving a dovetailed form is frequently combined (A) to prevent all risk of the joints opening.

Lagging-up. This is adopted in cylindrical pieces, as pipes, columns, and engine cylinders, when the diameter exceeds 4 in. or 5 in. The "lags" [**57**] are narrow strips laid round on cross bars and glued thereon, and also by their adjacent edges. The object is the same as in the preceding examples—namely, to localise and lessen the change of form. Solid stuff would curve on the joint faces [**58**], with loss of the truly circular form, while in a lagged-up pattern changes due to desiccation and moisture are localised. How this method is embodied in a pattern column is shown in **59**, which represents such a half pattern laid open in the joint face, with the cross bars to which the lags are attached. Methods of fitting flanges, end core prints, and mouldings are also indicated.

Segmental Construction. This is an exceedingly important detail of pattern-work, being adopted for nearly all patterns of sweeped and annular form, such as curved portions generally, and for the rims of wheels and pulleys of all dimensions. In principle it is paralleled by the disposition of bricks in a wall, in superimposed layers, with end joints alternating. The segments are sawn out, jointed, glued in layers, and frequently strengthened by the insertion of wooden pegs. The latter would not be employed but for the fact that the rough usage to which patterns are subjected in the foundry and the moisture of the sand are in time liable to overcome the adherence of the glue alone.

Example of Segmental Work. A typical example of segmental work is that afforded by the ring [**60**], for any common wheel. It is easy to see what would happen if such a ring as this were made of solid wood. However hard, close grained, and well seasoned it might be, it would not only become elliptical by the alternate wetting and drying to which it is subjected in the foundry, but the short grain would snap, and the pattern be falling to pieces before half a dozen moulds had been made from it. But being built up, there is no tendency to depart from the circular form; the only shrinkage which can take place being of a local character—namely, in the width of each individual segment, and in their thicknesses, the amounts of which are almost inappreciable.

Each glued segment binds its fellow, and the wheel is as strong as a wooden structure of this form can possibly be made, while the application of varnish prevents the glue from becoming moistened and working out of the joints by the action of the damp foundry sand. The drawing [**61**] illustrates the commencement of the building up, the first segments being glued to the face plate with paper joints. A pattern of a sheave pulley built up in this way is shown in plan, and half external view and half sectional view in **62**, with its dividing joint along a—a. The arms, also divided, it will be noted, are made of three separate pieces, lap-jointed together with "halvings," and are therefore strong, the grain being straight in each. A



BROAD TYPES OF PATTERN CONSTRUCTION

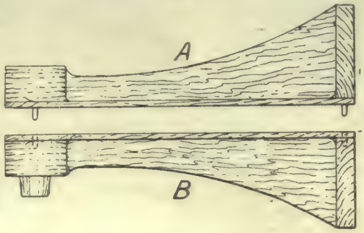
53. Example of open joints and boxing-up **54.** Boxing-up **55.** Improper method of boxing-up **56.** Halvings **57.** Lagged-up column **58.** Warping of solid timber **59.** Complete pattern column lagged up, with attachments **60.** Ring built in segments **61.** Commencement of the work **62.** Complete sheave-pulley pattern, built up in segments **63.** Pipe pattern, jointed along the centre **64.** Unjointed pipe pattern **65.** Iron pattern, unjointed

built-up wheel is the perfection of pattern work, and will stand moulding from hundreds of times.

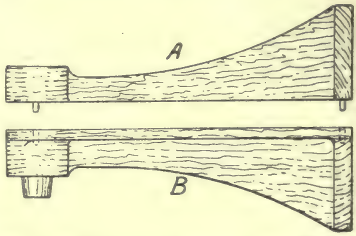
Metal Patterns. We have already mentioned the fact that metal is used for some patterns in preference to wood, with the reason for its employment. Cast iron, brass, white metals, are pressed into service. Always in such cases a pattern of wood or of plaster has to be made first, having double shrinkage, one shrinkage for the metal pattern, the other for the castings moulded from the latter. Generally, too, allowances must be made on the metal pattern for filing or tooling, to produce surfaces smooth enough and sufficiently accurate for moulding from. Lead and leather are both used frequently in patterns, the first-named for those which have to be of curved and awkward forms, the lead pattern being used from which to mould one in iron or brass. Also, the two materials are employed largely for lining up and thickening portions of patterns to effect slight alterations in them.

Varnish. Patterns are varnished to protect them from the moisture present in the sand, to preserve them, and to facilitate their withdrawal. A plain shellac and spirit varnish is generally used, in its natural yellow colour. Sometimes lampblack is mixed with it, and used on core prints to distinguish them from the other portions. Large cheap patterns are sometimes seared with a hot iron. Large patterns for permanent use are sometimes protected with two or three coats of oil paint.

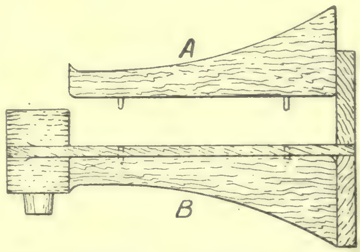
Jointing Patterns. We will now consider the pattern from the point of view of its delivery from the sand. This, as has been illustrated in the two preceding articles of this course, involves the great question of jointing.



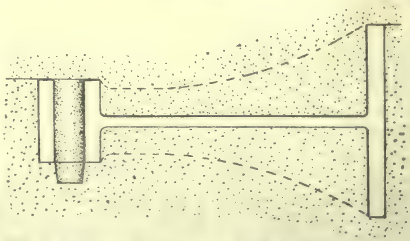
66. METHOD OF JOINTING BRACKET PATTERN



67. METHOD OF JOINTING BRACKET PATTERN



68. METHOD OF JOINTING BRACKET PATTERN


69. VERTICAL SECTION THROUGH MOULD OF BRACKET PATTERN

An observant youth on going into a pattern shop or a pattern stores for the first time would at once be struck by the fact that very few of the patterns were whole or entire. The bulk of them, probably nine-tenths of the total number, are pieced up, jointed in some way or another. Sometimes they are divided down the centre only, into two symmetrical halves; sometimes there are several divisions, in planes parallel with each other. Or the pattern, as a whole, is unjointed, but subsidiary portions are jointed in a loose and readily removable fashion. But in all cases means are taken to preserve the due relative positions of the several parts, so that when in their proper places with closed joints there is no risk of those relative positions being changed. The means employed to preserve these relationships are seen to be pins, or dowels, dovetails, and skewers, or wires.

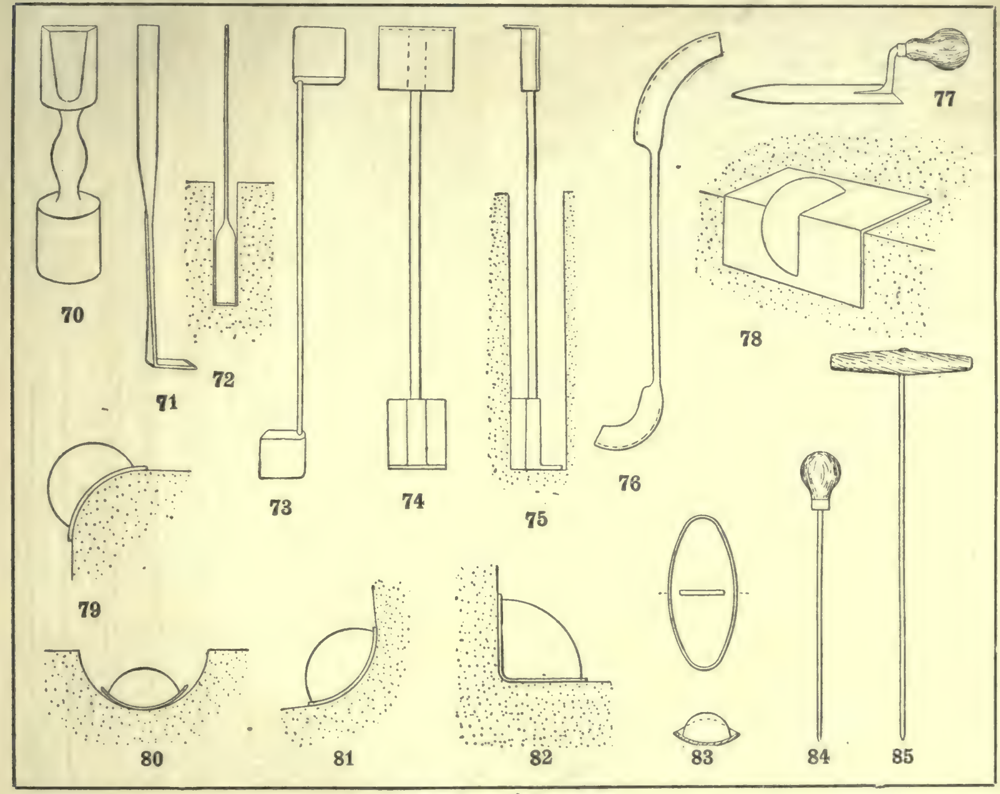
Reasons for Jointing. If, from the pattern shop the student goes into the foundry, he soon learns the reason for this jointing—that without it there would, in many cases, be no possibility of withdrawing the patterns without producing violent disturbance and fracture of the sand, quite destructive of its accurate shape and outlines. He sees that the joints in patterns, and in foundry boxes and moulds generally, correspond, but that in others they do not, except in an approximate fashion. In this way he learns the difference between the plain and obvious joints of boxes, and those of sloping joints, drawbacks, and rings of sand carried on grids. In many cases, also, though joints are not absolutely necessary for the proper withdrawal of the pattern, they are seen to be nevertheless desirable, either for the easier cleaning up of the mould, or for the insertion of cores, or to save additional jointing of moulding-boxes. Further, he observes the reason why dowels, dovetails, and skewers are employed, since without them the pattern sections would become moved relatively to one another in the mould by the process of ramming; hence he will conclude that proper jointing lies at the very foundation of the art and trade of pattern-making, and that there is only one reason for the jointing of patterns—namely, to facilitate the clean withdrawal of the pattern sections from the mould.

Varieties of Joints. The plainest and commonest joints are those which coincide precisely with the joint of the mould and of the moulding-box. This type of pattern

is represented by the cylinder, pipe, or column, jointed longitudinally down the central plane or axis. This divides the pattern into symmetrical halves, one of which goes in the bottom, and one in the top box. Fig. **63** is a pattern of this type, jointed and dowelled in the plane *a—a*. Nine-tenths of patterns of this type used for jobbing and casual orders, and large quantities for standard work—those of very small diameter excepted—are jointed in this way.

The exceptions to the common practice are several, but may be included under two heads, as follows: Patterns unjointed, being so made with a view to economy, and patterns made brassfounders do much less jointing than ironfounders, employing bottom, or joint boards, by which the labour of making sand joints by hand afresh for every mould is saved. Fig. **65** shows a pattern made of iron for producing the same moulds as **63** and **64**. It is cast hollow, to lighten it, and the top flange, of wood, is left loose. Such a pattern is generally turned smooth in the lathe.

There is a good deal of give and take in moulding and pattern making. The bracket pattern [**66—68**] illustrates the fact that patterns and moulds alike might be equally well jointed in three different ways, and this is only typical of



MOULDERS' TOOLS

70. Small bench rammer **71.** Cleaner **72.** Cleaner in use **73.** Another form of cleaner **74** and **75.** Boss tool **76.** Flange bead **77.** Trowel **78.** Square-corner sleeker **79.** Round-corner sleeker **80** and **81.** Pipe smoothers **82.** Square-corner sleeker **83.** Button or bacca-box smoother **84** and **85.** Vent wires

unjointed either in order to prevent risk of lapping joints in their castings, or to maintain the maximum strength possible. Thus, the pattern is often made as in **64**, solidly, but leaving the top halves of the flanges loose, for reasons given in a previous section. In **63** the pattern joint coincides absolutely with that of the mould; in **64**, the two only match at the jointing of the flanges, yet the joint of the mould must be carried along the central, or longitudinal, plane of the pipe, just as in **63**.

Jointless Patterns. This device of making patterns without joints is adopted generally in those made of metal. The alternatives in practice that are for ever occurring. The drawings are almost self-explanatory. In **66** the jointing of pattern and mould alike takes place in a horizontal plane that coincides with the exact centre of the bracket. In **67** the joint is made on the top face of the main web, the advantage of which is a slightly stronger pattern, because the web or plate is in one thickness. In both cases the portions A A come in the top box, and B B in the bottom. In **68**, the top rib only is dowelled loosely, and here the rib is the only portion that is left in the top. The mould joint, instead of being in a strictly horizontal plane, follows the outlines

shown in **69**, the rib and a bit of the boss being the only portions in the top of the mould.

Systems of Moulding. Turning now to the great divisions of the moulder's work, we revert to the remarks made on page 2110 of this course relating to the differences in sand —strong and weak, green, dry, loam—and cores. In the main these coincide with the great divisions which exist in foundry work, but not absolutely so. A more natural and all-embracing classification is that of bedding-in, turning over, sweeping, and machine moulding. Both strong and weak sands are used in bedding-in and in turning over, both green sand and loam in sweeping up, and cores are present in every class of work. Machine moulding deals with all kinds of sands, loam excepted, but it is done principally in green sand. We shall consider presently the broad methods just enumerated, prefacing the subject with a brief mention of the principal tools common to all branches alike.

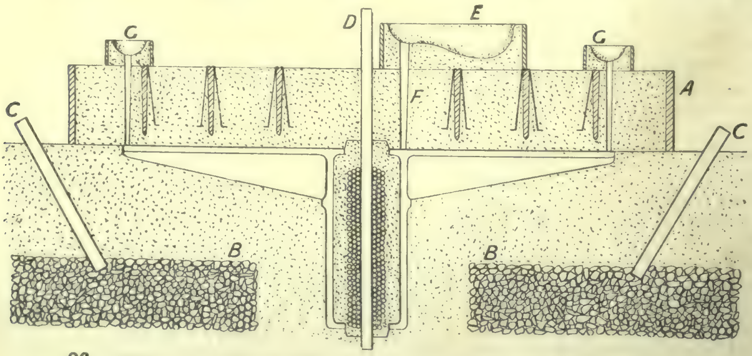
Moulders' Tools. The group **70—85** illustrates the principal tools used by moulders. It will be noted that they mostly belong to the same broad divisions as those employed by plasterers and modellers—that is, they impart shapes to the sand by pressure chiefly, and that their shapes are generally the counterparts of the impressions they produce. Rammers are an exception. Some were shown on a previous page [2111].

Running through the group, **70** is a small *bench rammer*, double ended, the upper end in the figure being the pegging end, the lower end being for flat ramming; **71** is a *cleaner*, used for smoothing vertical faces in narrow openings or the bottoms of narrow spaces (as shown in **72**); **73** is another form of cleaner; **74** and **75** are front and edge views of a *boss tool*, employed for smoothing the edges and bottom faces of boss moulds, and made double-ended with different radii; **76** is a *flange bead*—that is, its curved working ends are rectangular in cross-section for smoothing the edges of flange moulds. If made with flatter curves, it is a *girder tool*. Similar tools made convex in cross-section are *bead tools* or *circular beads*. Fig. **77** is a *trowel* made in four forms—the *taper* trowel shown, the *square*, or *Scotch* trowel, the *long heart*, and the *broad heart*; and double-ended with an iron connecting shank, as the *heart* and *square*, all used for smoothing flat faces of sand, and much useful work besides. Figs. **78—83** are various *sleekers*, or *smoothers*. As each is shown in the act of smoothing a body of sand the utilities are apparent. Figs. **78** and **82** are *square-corner sleekers*, but **79** is a *round-corner sleeker*. Figs. **80** and **81** are *pipe smoothers*; **83** boasts the title of *button smoother* or *bacca-box smoother*; **84** and **85** are *vent wires*, and **84** is commonly used as a *picker* for withdrawing small patterns.

Bedding-in. The sphere of bedding-in lies mostly in heavy work which is too large for the capacities of ordinary moulding boxes. The pattern is rammed in the floor sand in the position corresponding with that of its casting—that is, bottom side lowermost—and the mould is covered with a plain top-box. The method is also adopted in patterns of medium dimensions if boxes of suitable size or shape do not happen to be available. It is, moreover, to some extent decided by the general practice of a given shop, some foundries doing more in this way than others. There are several disadvantages in its adoption, one of the principal being the difficulty of ensuring even ramming, another the necessity for laying down a cinder-bed to receive the air from the vents.

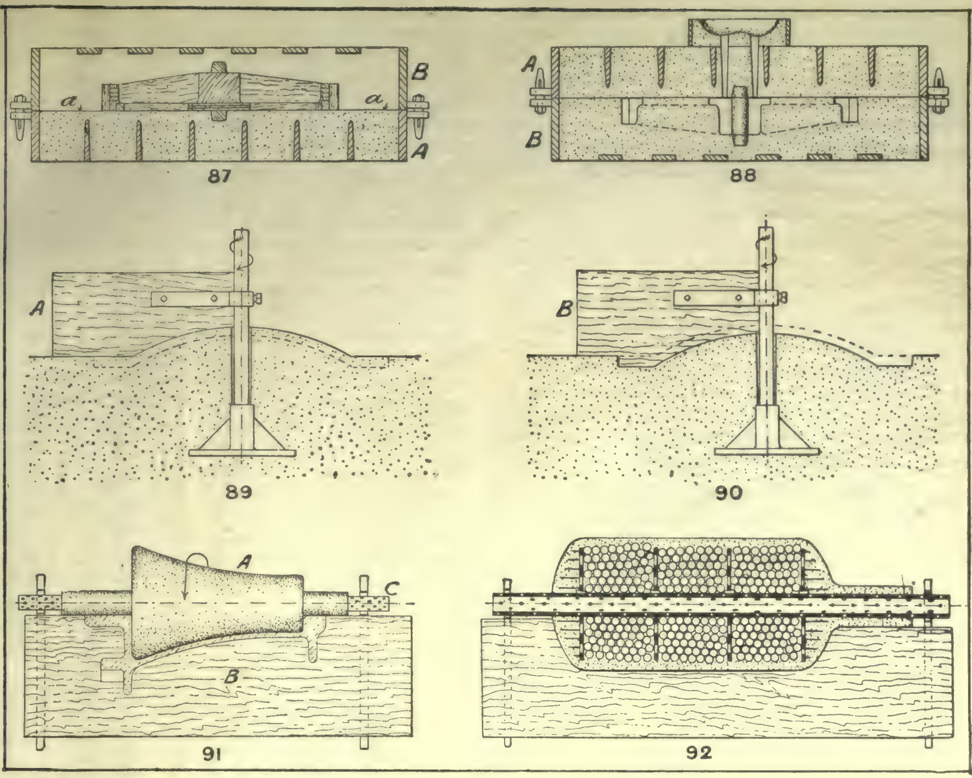
Bedding-in assumes two phases—that in which the surface of the bed is level, or approximately so, and that where the form is very irregular in the vertical planes. In the first case a bed is levelled, using two winding strips set in the sand with a spirit level, and making their upper edges the guides by which to strickle off a truly horizontal bed, upon which the bottom face of the pattern is laid, to be succeeded by the ramming of the sides. Level beds are also often made with a plain striking-board attached to a central bar. If the board be truly horizontal it is evident that the bed will be horizontal also in every portion of its area.

Bedding-in Irregular Patterns. But when the lower face of a pattern is of irregular outlines, or shallow and deeper in different parts, the pattern has to be lightly beaten down into the sand and removed, and the sand gone over in detail by the moulder carefully ramming it to suitable consistency, and this may have to be repeated three or four times in succession before the pattern makes a proper bedding. The ramming of the sides is easy enough, but it is obvious that the bottom sand—that underneath the pattern—cannot be rammed while the pattern remains in place.



86. VERTICAL SECTION THROUGH MOULD MADE BY BEDDING-IN

Fig. **86** illustrates a vertical section through a completed mould made by bedding-in, with top box A, cinder-bed B, and vent pipes C C. D is



ILLUSTRATIONS OF MOULDING PRACTICE

87 and 88. Two stages in mould made by turning over **89 and 90.** Two views of mould made by sweeping-up **91.** Sweeping up a core **92.** Section through a swept-up core

the vent pipe from the boss core, E the pouring basin, F the runner, G G flow-off gates, or risers. Lifters will be noticed suspended from the box bars.

Turning Over. In this method, which includes much the larger majority of moulds made, the face of the mould that is lowermost at the time of casting is rammed first and uppermost, to be turned over subsequently. The great advantage is that the sand is rammed directly against the face of the pattern, and therefore its proper consolidation is more easily effected than by bedding-in.

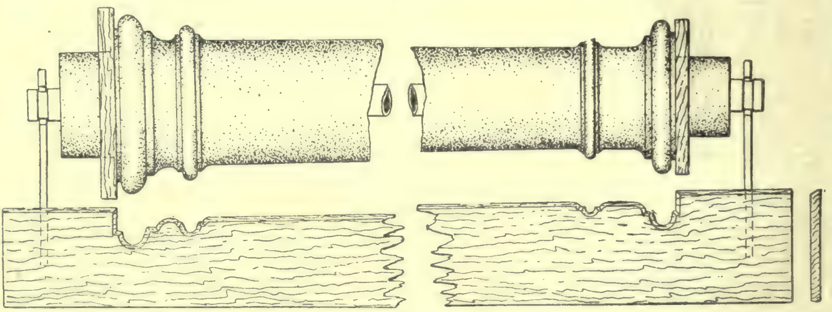
To mould by turning over, the pattern is first laid on a very loosely rammed body of sand either on the floor or on what is to be the top box, and with its bottom face uppermost. Fig. 87 shows the first stage in moulding a spur wheel laid upon the top box. A joint face (*a a*) has been made on the body of sand roughly shovelled into A and tramped down, the joint face dusted with parting sand, and the box B, which is to come in the bottom, has been laid on and rammed over the pattern face and down the sides of the teeth. The two box parts being then cottared together, are turned over [**88**], bringing the bottom box (B) into the position which it will retain until casting. The top (A) is then lifted off, its comparatively loose sand knocked out, the joint face brushed over, strewn with parting sand, and then set over for its permanent ramming on the top face of the pattern. It is then lifted off its fellow, and the pattern is withdrawn. The mould is then cleaned and cored, and the top put on, the pouring basin made—the stage seen in **88**—and the metal run into the mould.

Sweeping. This is an important economical section of foundry work. It signifies the making of certain moulds without patterns—those moulds which, being of symmetrical shapes, can be prepared by a process of formative scraping, *sweeping*, or *strickling* of sand, and of loam. It includes work both in green and in dried sands, and in plastic loam, the formation of cylindrical, annular, and curved cores in core sand and in loam. It may also be either that a mould or core is produced wholly by this process, or, as is often the case, that the main portion only is so made, and for which several separate pattern pieces have to be prepared in wood and embedded. Allied to this is the sweeping of large patterns in loam instead of making them more expensively in timber, and then, too, wood pattern parts are often attached to loam bodies. These afford very many examples of mutual give-and-take between moulder and pattern-maker, with the object of economical manufacture.

Methods of Sweeping. Sweeping up is done first by the revolution of a board

set vertically, having an edge cut to any required profile, and chamfered, and fastened to a spindle at a certain definite distance from the centre of rotation—works in loam are commonly struck or swept thus—or, secondly, by the revolution of a horizontal core-bar, with its covering of haybands and loam against a similar board laid on trestles. Cores are struck up in this way. Or, again, by the guidance of a templet or strickle against the edge of a plate, or a rod of iron, either cores or loam patterns whose outlines are not symmetrical in the longitudinal direction are readily struck up. In each case the pattern-makers' work is almost nil, while that of the moulder is rendered more responsible. The importance of an intimate knowledge of the entire details of sweep-work, including the choice of the best and most economical methods of striking up, the most practicable details, the conditions under which moulds and cores must be made is therefore indispensable.

Green Sand Sweeping. Figs. **89** and **90** illustrate how a mould is swept up in green sand. It is a large dished cover, the pattern for which would be expensive, but the boards would cost little, while the time occupied in sweeping



93. A LOAM PATTERN MADE BY SWEEPING UP

need not be much greater than would be spent in moulding from a pattern.

Two striking-boards are required. A in **89** sweeps a dummy mould upon which the top box is rammed; B then is substituted to strike the bottom directly. Or the top might be swept directly by a board cut the reverse to A, the top mould being then turned over on the bottom one. Or the convex side of the cover might be moulded downwards instead of upwards.

Cylindrical Sweeping. Cases that are always occurring are the sweeping of cylindrical cores, loam patterns, and loam moulds, with or without extraneous fittings. In each of these, loam is struck against the edges of boards which are the counterparts of the forms struck, or the profile boards are worked over the loam. In the making of wooden patterns or core boxes of large dimensions, all intricate and involved outlines, curves, and mouldings materially increase the expense of pattern work, often rendering it out of all reasonable proportion to the cost of the casting or castings required. But the expense of cutting the striking edge of a board or boards is a mere trifle, and is not affected at all by the question of diameter, that being then a question of moulder's labour and not of pattern work at all. The question of relative cost between striking-boards and complete patterns would be usually one of a few shillings versus many pounds.

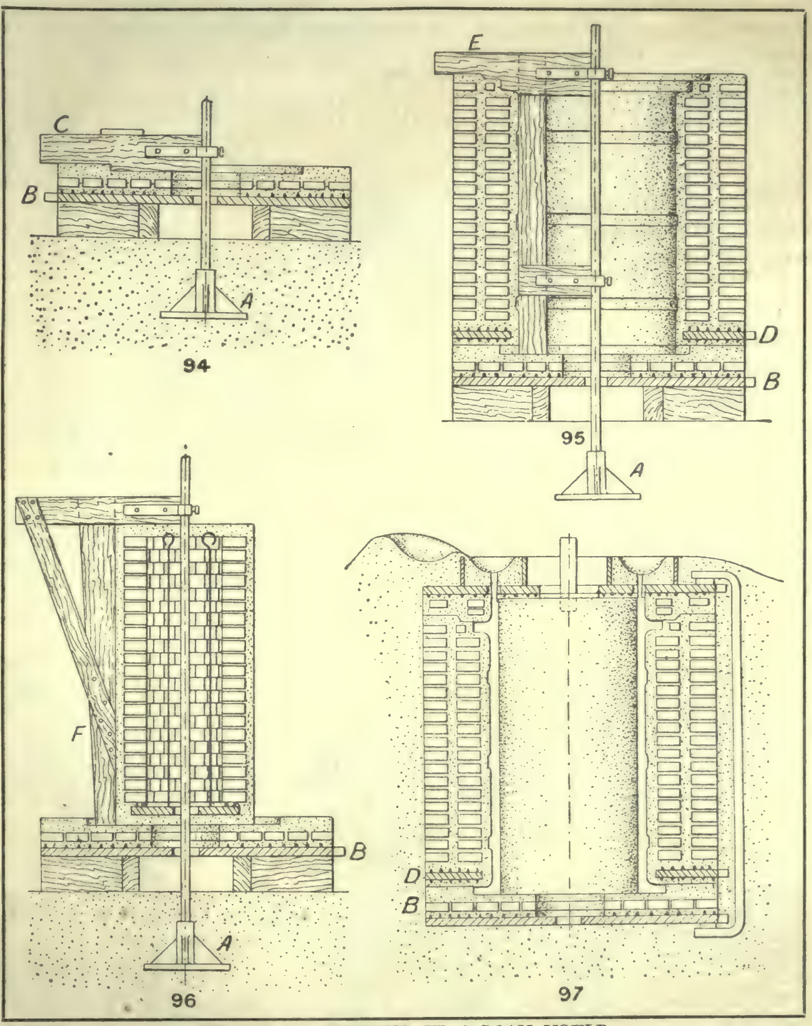
Examples of Sweeping-up. Fig. **91** illustrates the sweeping up of a core A, for a fusee drum, against a board B; C being the core-bar, pierced with vent holes. The outline of the pattern is seen marked upon the board as a guide to the moulder in setting the core in place. This device is a good one to adopt. Fig. **92** shows a core in section for an air vessel, with its board. The central core-bar is seen to be encircled with plates to retain the haybands, on and among which the loam is plastered. The end plates have prods to carry the loam there. Fig. **93** is a column pattern swept in loam against its board, the board being shown withdrawn away. Here the top and bottom flanges are made separately in wood, and slipped on the loam body. The iron bar seen projecting at the ends has journals turned on it to run in the core trestles. The body of the loam is built up on plates and hayropes as in **92**.

Work which is in the main symmetrical, as in **93**, often includes other attachments of more or less irregular outline to be made as separate parts and fitted to the struck-up pattern, core or mould. The flanges in **93** are a mere nothing in comparison with the fittings to, say, a hydraulic cylinder. Sometimes these are so numerous that it becomes a question whether in view of the time occupied in making and fitting such pieces to the circular portion of a mould —with the possible risk of their becoming displaced—it is not cheaper to make an entire pattern of wood. Such jobs do occur frequently, occupying the border-line between economical and non-economical striking up of work.

Sweeping in Loam. This involves the employment of bricks as a skeleton framework to support the loam, and the use of iron rings to carry the bricks. This is a distinct branch of moulding, involving very different methods of treatment from those of green sand work, and it is usually practised by men who do not work in green sand. The main outlines of the moulds are produced by means of a board or boards having chamfered edges, and attached to a central bar turning in a socket. In many, or in most cases, there will be portions that

cannot be swept, but for which pattern pieces will be wanted, and these are embedded in the loam, being set by measurement, and so constructed as to be readily withdrawn after the loam has become partially or wholly set.

The brickwork skeleton or framework of a loam mould which forms the backing for the loam is cemented together also with loam, and the spacing of the joints is left wide to permit of due shrinking of the mould, and of sufficient venting spaces. In situations where the shrinkage is considerable, or where it is necessary to cut away portions of the mould, or where a portion of the mould has to be rapidly removed soon after casting, loam bricks—that is, loam moulded in the form of bricks and dried—are used.



STAGES IN SWEEPING UP A LOAM MOULD

Loam moulds generally make the best castings, because, owing to the moulds being thoroughly dry, there is much less gas generated than in green sand moulds; and the surface of the mould is hard, and therefore better able to withstand pressure of metal.

Cylinder Moulding in Loam. Figs. 94 to 97 illustrate the moulding of a plain cylinder in loam. The socket is seen at A, carrying the striking bar to which the boards are attached. The plates, bricks, and loam are all shown. Briefly, the sequence of operations is as follows:

The base of the mould is the plate (B in 94) prodded, and which, being bricked over, receives the loam, swept to outline with the board (C) that forms the bottom flange. This is then dried in the stove. Upon it another plate (D) has to be carried to sustain the outside of the mould, and this plate has to be swept over on both sides, the lower side to make a joint with the loam on B. This involves sweeping, drying, and turning over into place in order that the outer mould shall be built up on it, in which position it is shown in 95. As the loam would tumble down and fill up the flange already swept, this is temporarily filled with sand [95] during the building up of the bricks on D, and the sweeping of the mould with the board (E). This is then dried while the core, and the top, or cope, is being swept. The core is built around bricks on a plate [96] with lifting eyes, by the sweeping board (F). The cope is swept up similarly to the bottom [94], and dried and turned over into place, after the insertion of the core [97], completing the mould. The top and bottom plates being clamped or bolted together fasten the mould securely, and the annular pouring basin is made within an iron ring on the top plate [97].

Continued

Group 29
TRANSIT
3
Continued from page 2280

CLASSES OF VEHICLES

A Comprehensive Description of Passenger and Goods Vehicles for Road and Railway, for both Private Use and Public Service

By H. J. BUTLER

THE formation of roads and their maintenance is one of the chief factors by which the progress of a country is determined. Being given these means of communication, the next step is to make the best use of them by the employment of suitable vehicles whereby we ourselves may be quickly and safely conducted from one place to another, and by means of which all classes of goods may be transported with despatch. The advent of the railway at the beginning of last century was a big step forward in the development of vehicular traffic, and made an enormous difference to trade and the welfare of the country generally. At present we have the advent of the motor-car, which will develop the use of our highways to the utmost.

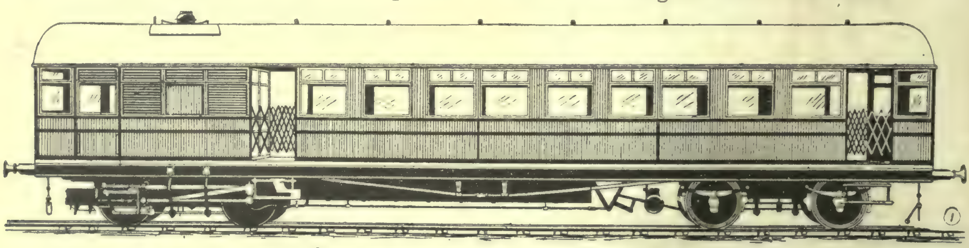
Surely, then, the study of the different classes of vehicles may call for our interest, seeing that we depend so much on their existence. In their variety, and the ingenuity displayed by their constructors, there is much that is interesting and worthy of examination.

Classes of Vehicles. Vehicles are broadly divided into two classes: (1) Passenger Vehicles; (2) Goods Vehicles. Passenger Vehicles may again be subdivided into: (*a*) Railway Rolling Stock, including Tramcars; (*b*) Motor-cars and motor-cycles; (*c*) Carriages, private and public; (*d*) Cycles. Goods vehicles also have their subdivisions. The more numerous class are separated into: (*a*) Railway and Tramway Rolling Stock; (*b*) Motor-cars; (*c*) Vans, Waggons, Carts; (*d*) Cycle Carriers, Trucks, and other small types.

Passenger Railway Vehicles. Passenger railway rolling stock serves the business man for getting from suburb to town, and from one town to another. Four and six wheeled carriages, fitted with separate transverse compartments, constitute a type that has had its day. The introduction of the four and six wheeled bogie or pivoted under-carriage at once allowed the increase in the length of the vehicle, and now we have carriages up to over 70 ft. in length. Some of the recent types are veritable travelling palaces of comfort, and are fitted up as breakfast, luncheon, dining, and picnic saloons, and adapted for the preparation as well as the serving of meals. Thus one may sleep, read, smoke, observe the country through which one passes, stroll from end to end of the train, and, where long distances are encountered, as on the continent of America, one's personal comfort is studied, even to the ministrations of the barber. Trains nowadays are well lighted in the later types, besides being heated more effectively, and, should emergency arise, means are provided to gain assistance. Even on trains running comparatively short distances every lavatorial convenience is supplied, every effort being made to combine the pleasures of travelling with the comforts of home.

Although so much thought is displayed on the interior in railway work, it must be admitted that the exterior, although plain, is neat and symmetrical.

Types of Railway Carriages. There are first, second, and third-class carriages, which may be of the compartment, corridor, or corridor-vestibule type. *Composite* is a term applied to carriages accommodating more than one class of passenger, and if with a guard or luggage compartment is termed a *brake composite.* Brake-vans are those entirely set apart for luggage and the travelling custodian of the train.

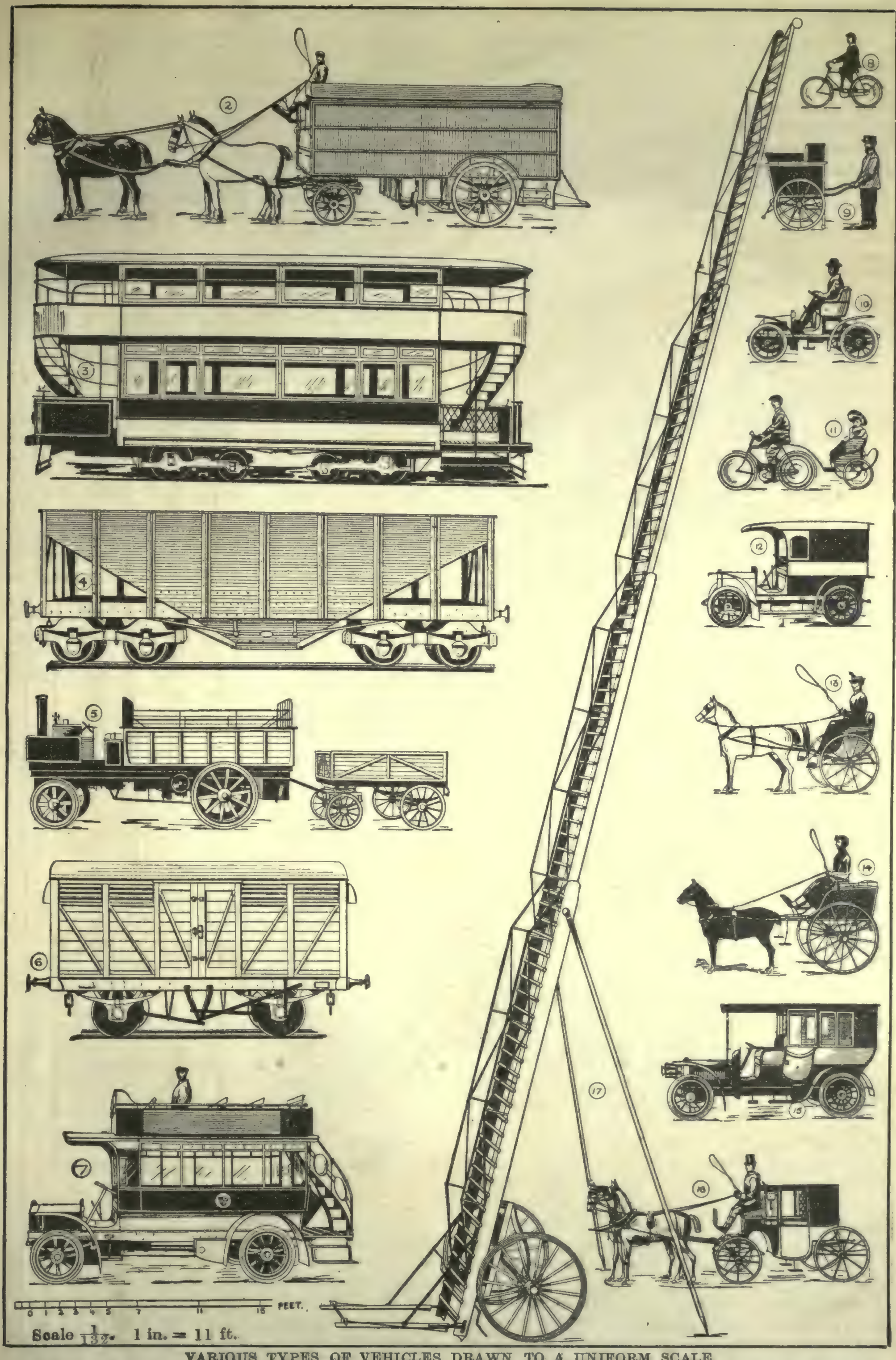


1. RAILWAY STEAM MOTOR COACH

Besides dining and sleeping cars and those already mentioned, there are family saloons and various special cars, such as are provided for Royalty. Under this heading may be included the various mail vans, for they usually travel as a part of a passenger train.

Railway builders do not favour the double-deck style, but carriages of this type may be seen around Paris and in Portugal; their further construction, however, is being discontinued. This type of vehicle is closely allied to our street double-decked tramcars, which we shall now consider.

Tramcars. Tramcars are single and double decked [3]. The horse-drawn variety is on the wane, and although cable, steam, compressed air, and other mechanical means are, and have been, used, the electric car, be it on

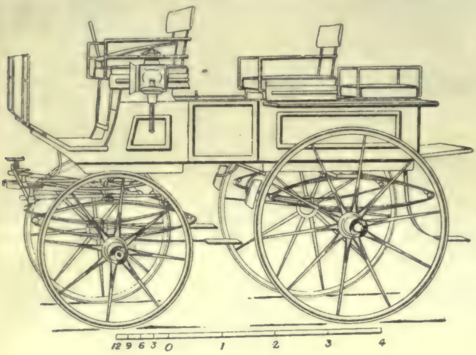


VARIOUS TYPES OF VEHICLES DRAWN TO A UNIFORM SCALE

2. Pantechnicon drawn by three horses 3. Double-decked, conduit system, electric car 4. High capacity hopper waggon, central discharge 5. Five-ton steam van with 3-ton trailer 6. Covered railway goods waggon 7. Double-decked motor omnibus 8. Juvenile cyclist 9. Baker's barrow 10. Two-seated petrol car 11. Petrol motor cycle and trailer 12. Petrol light delivery van 13. Lady's driving car 14. Butcher's cart 15. Seven-seated petrol motor car 16. Double brougham 17. 85 ft. 4-ladder fire escape, standing on its own support poles and fully extended.

the trolley or conduit system, is no doubt the type that is before us, unless the motor omnibus people succeed in proving effectually that their system is more economical, especially when ratepayers have to be considered.

Trams are suitable for conveying passengers from one to six miles, and, as may be expected, are keen rivals to the suburban railway traffic.



18. BEAUFORT PHAETON

The single deck, practically monopolised in the States, may have a closed body or be open to the floor or waist. *Composite* (a different designation to the railway term) cars consist either of a closed central general compartment and closed end smoking compartments with seats on the platform, or the centre part only may be closed and the rest open. The double-deck types have their various forms of stairways, more or less successful in keeping the streams of passengers to the roof and interior separate, and both classes may have end vestibules to form protection from the weather, and the seating may be either of the transverse or longitudinal type both inside and outside.

Motor-cars. Motor-cars that convey passengers are divided into *touring* or *pleasure* cars and those set apart for *racing*. In the general design of the body of the motor-car one sees a certain originality in the outward form, and, being a speedier vehicle than its horsed prototype, much development has taken place in schemes for protection from the weather. The speed also determines that the body shall be panelled and not of the open sticked or simple rail type, a remark of course applying to railway work.

The engineer classes the various types under the different makes of engines and means of transmission. The coachbuilder makes his divisions according to the type of body. The small *two-seater* [10] is sometimes fitted with a third fixed or collapsible seat, and occasionally a vis-à-vis seat. The two-seated vehicle in a simpler form, with more powerful mechanism, becomes a racing car. Sometimes the car is enclosed, and then resembles a brougham without a driving-seat.

Then comes a large class, the *tonneau*, a type that has a special plan shape, first being made with cramped proportions, and hind or front entrance, now more comfortably designed, and, as in many other types, fitted with a side entrance. *Limousines* [21] are bodies that are enclosed, not necessarily the driver's seat, and in which the occupants face forward. Entrance is made from the front, side, and back.

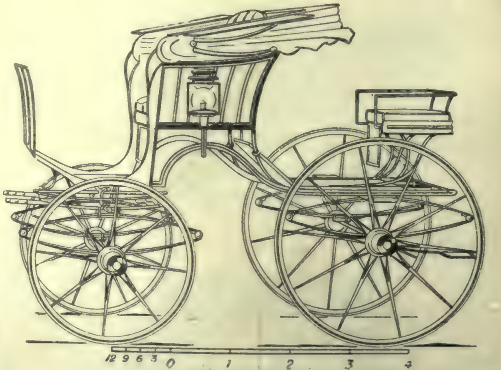
In the body of a *waggonette* one sits face to face along the length of the vehicle. When fitted with a side-folding leather head it is termed usually a *Lonsdale waggonette.* A waggonette fitted with a solid top becomes an omnibus. Often the top is removable, a remark applying to limousines.

Motor Omnibuses. *Omnibuses*, as their name suggests, are used for public service purposes, and London, in conjunction with other towns, is daily increasing the number on the streets. There is the small private type, seating from four in the body, to the double-deck public service omnibus, holding in all from 32 to 42 passengers [7].

A favourite vehicle that has been copied from the horse-drawn type is the *landaulette* [22]. This has a folding head, making the carriage suitable either for fine or bad, hot or cold weather. It can be used for shopping, paying calls, or the opera. The single type holds normally two, and the double, with its square, or Dee front, holds four in the body. The front may be either fixed or made wholly or partly to fold. The *Brougham* is similar to the landaulette, except that the top is fixed and not made to fold. Then, continuing through the list, there may be noted the various *phaeton types*, besides private and public *hansoms*; but these will be mentioned at greater length under Horse Vehicles.

The remaining patterns include *saloon*, or *pullman cars*, noteworthy for the luxury and comfort of their fitments, and the various large cars seating six, seven, and eight persons.

All types, except those already fitted with weather protection—*viz.*, broughams, laudaulettes, limousines, and single-deck 'buses, have



19. SPIDER PHAETON

designed for them when required various folding leather heads, cape cart and double extension heads, canopies, and glass screens placed in the front, the centre, or the back of the car.

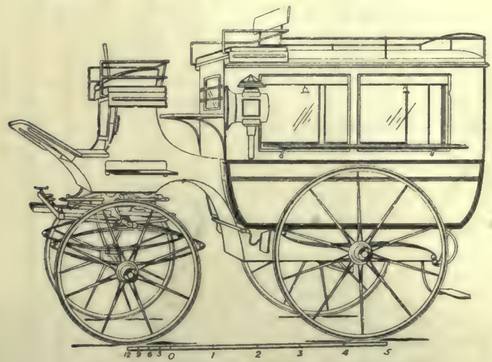
Motor-cycles. *Motor-cycles* [11] are more popular in the two-wheeled form, and represent the cheapest form of the automobile. Tricycles are not so much used as formerly, and when

more than two wheels are adopted it is usually in the form of the tricar or "quad"—a class of vehicle which in some instances resembles closely the lighter forms of motor-cars.

Horse Carriages. This brings us to the trade that is much threatened, especially as regards new work, owing to the coming of the automobile. Still, the principles of construction used in this work are the basis on which railway carriages and motor bodies have taken their copy, and it will be remembered that the earlier types were so like their horse-drawn examples that the new form of locomotion brought upon itself much contempt. In the same way that railway-carriage builders have designed for themselves special vehicles suited to their needs, so a similar process of evolution is being performed with regard to autocars.

We first of all notice the *drag*, or four-in-hand, the remnant of the old stage-coach days, now for the most part a gentleman's driving carriage, especially if he be a member of the Coaching or Four-in-Hand Club. It consists of a small coach-body (more used for bags and wraps than passengers), front and hind boots, the former carrying the driving seat, which accommodates the holder of the "ribbons" and the lady occupying the seat of honour. On the hind boot is erected the seat set apart for the two grooms, or one extra passenger if necessary, while the roof is fitted with dos-à-dos seats holding three or four apiece, the feet being placed on the boots. Drawn by four horses, provided with extra splintrees, and luncheon arrangements, mounted on its mail under-carriage, it forms a splendid equipage.

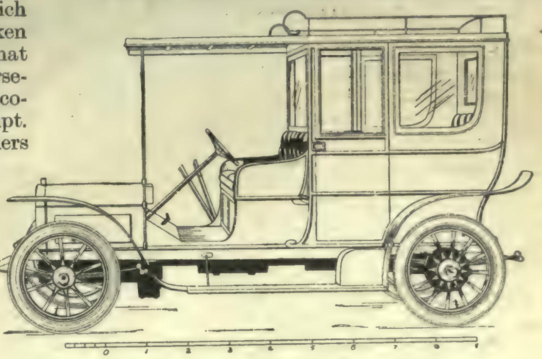
Coaches may be angular or of curved pattern, usually mounted on elliptic springs, the upper quarters panelled. Sometimes the front quarter is glazed, but very seldom the hind quarter.



20. PAIR-HORSE STATION OMNIBUS

Coaches carry four inside and two on the driving seat. They are not much used now, except when attending the obsequies of a friend, and they are drawn by one horse or by two horses. *State coaches*, as their name implies, are used on special occasions, and are of generous proportions and elaborate design being drawn by two or more horses, and often mounted on C and under springs.

Landaus and Broughams. A *landau*, whether of the angular, curved, or canoe pattern, is a vehicle seating four inside, but is roomier than a double landaulette, as described under Motor Bodies, and the front seat has a folding head also, so we have a double-folding head, meeting over the doorway. This collapsible head is perhaps one of the most useful inventions



21. SIDE-ENTRY LIMOUSINE PETROL MOTOR-CAR

applied to road vehicles. Landaus are drawn by one horse or by two horses. King Edward VII. had a new *State landau* built for him recently, and it is the only one in the British Royal household. It has been drawn by the eight cream horses familiar to sightseers. *Landaulettes* are either of the curved or angular type, and find little favour, strange to say, as horse-drawn vehicles.

Broughams drawn by one or two horses are curved [16] or angular [23] in outline, or a combination of the two, and are single and double, as landaulettes. A circular fronted brougham (also a landaulette) seats three in the body. All types can accommodate two on the driving seat.

A *four-wheeler* is a square-fronted brougham. A *dress chariot* is a full-quartered, two-seated body, provided, as most semi-dress, dress, semi-State, and State vehicles are, with a hammer-cloth and cradle seat, Salisbury boot, hind standards, box, bound platform, and block, all suitably carved. Sometimes a folding head is provided. Chariots were much in vogue 100 years ago, and earlier, but now they are seldom seen.

Barouches and Sociables. *Barouches*, originally constructed with deep panels, now with shallow, are similar in shape as regards the body to a canoe landau, but only the hind seat is protected with a folding head, the front seat being protected with a flap. On C and under springs a barouche is a noble carriage when mounted with front scrolls, splasher, folding step, and high driving-seat. Barouches are also made with solid ordinary boots and mounted on elliptic springs, short wings being used.

Sociables are curved or angular in outline, and may be full or open panelled. The seats are protected as in barouches; long wings, extending to the steps, or short elbow wings, are used, and the term "sociable" is designated by the best authorities to a vehicle with a door. A *double*

victoria is a similar carriage, but without a door, usually with long wings. A *barouche sociable* has the body of a sociable with the refinements of a barouche.

Omnibuses. *Private omnibuses* range from the single-horse vehicle carrying two on the driving seat and four in the body, to the heavy pair-horse type [20] holding eight inside, three on the roof, three on the box, and perhaps a hind groom's seat. It is used for station work. Railway companies, hotels, and other large establishments maintain their own omnibuses.

The familiar *garden-seat omnibus*, much condemned by those who themselves cannot improve it, needs no description, except to say that as regards distribution of weight on the wheels it stands unrivalled. Born in France, introduced into London by Shillibeer as a single decker, it is one of the chief items of traffic in the main thoroughfares of the metropolis.

Waggonettes carry two passengers in front and four or more in the body. Besides the *Lonsdale waggonette*, as mentioned under Motor-Cars, the *Fife waggonette*, with a large folding head, similar in operation to the front seat of a landau, is occasionally adopted.

A *waggonette brake* has a high driving-boot, is fitted for at least a pair of horses, and is often used for exercising. The largest types are well known, catering as they do for beanfeast and sight-seeing parties.

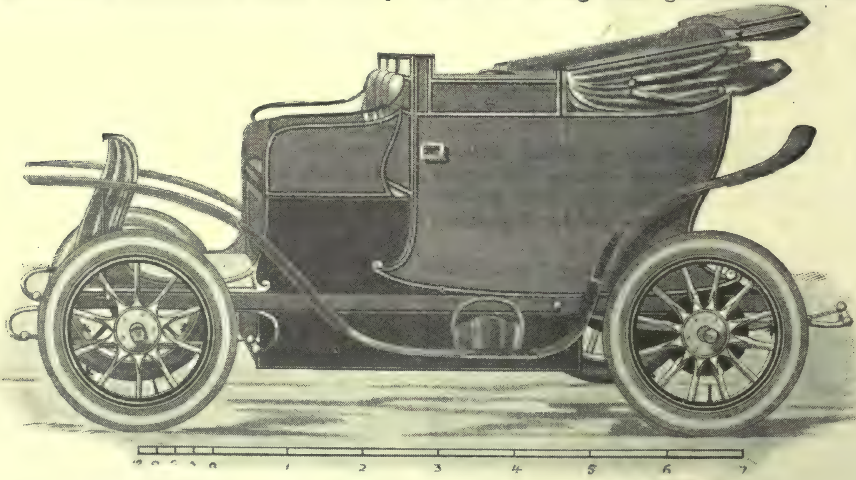
The gentleman's *char-à-banc* is made in many designs. It has normally four seats, facing according to taste, either high or low, open or panelled. It always has a high driving-seat, and is fitted for at least a pair of horses. The public service type has a use similar to that of the brake mentioned above. *Beaufort phaetons* [18] are a type of char-à-banc.

Phaetons. *Phaetons* embrace a large class of vehicles. *Victoria phaetons*, better known simply as *victorias*, are curved or angular in outline, open or full panelled. They carry two in the body, which is protected by a folding head, and is much lower than the driving seat. A *Stanhope phaeton* has a front curved pillar and rails to the front seat, hind seat with irons, oblong box body, usually provided with an arch, and folding head to front seat. If no folding head, it has a special designation—"T" cart. *Mail phaetons* are mounted on a mail under-carriage, have no arch, a heavier body with well, and are provided with a folding head similar to the Stanhope. The hind seat has a double rail. A *demi-mail phaeton* has the characteristics of both the mail and Stanhope. A *Vienna phaeton* is an angular Victoria phaeton. *Park phaetons*, or lady's driving phaetons, usually have a folding head to the hind driving-seat, with hind rumble for groom; generally a splasher in front, sometimes a vis-à-vis front seat. *Spider*, or *skeleton phaetons* [19] have a folding head to the high front seat, and are mounted on iron or wood-cased cranes, the groom's seat being at their hind extremity. *Road phaetons* and *dog-cart phaetons* have dos-à-dos seats, are adapted for carrying dogs or luggage, and are mounted on a box body, which may be slatted, or solid-sided, or provided with panels or sham louvres.

Two-wheeled Carriages. Having dealt with four-wheeled vehicles, we shall now consider briefly the two-wheeled varieties.

The *hansom cab*, most numerous of London's public vehicles, is a refinement of the type introduced in 1834. The position of the driver and the sliding front glasses are well known. Private hansoms are not uncommon, being patronised by Royalty. The hansom cab front is adopted in several types of two-wheeled carts, the advantage being its ease of access.

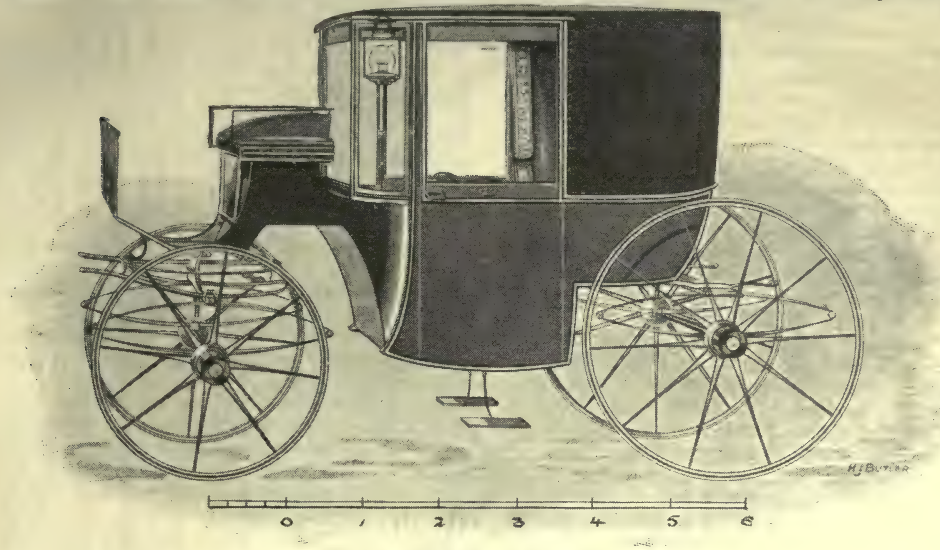
Gigs are vehicles seating only two, and in their different forms have been in vogue for a great many years. The *Stanhope* gig has a front like the Stanhope phaeton or waggonette, bent, strongly-plated ash shafts, and is mounted on two side and two cross-springs. The *Dennet* is a gig mounted on two side and one cross spring only, while the *Tilbury*, now little used,



22. ELECTRIC SINGLE LANDAULETTE WITH UNDERSLUNG BATTERY

has two side, two front elbow, two hind elbow, and a cross-spring, and the part of the body under the seat line is much cut away. Polo, or *Liverpool gigs*, or, better, *carts*, are frame-sided, two wheelers, and carry two persons.

Carts and Cars [13]. Carts and cars have many fancy names, and their variety is very great. When seating two and four, the seats



23. ANGULAR DOUBLE BROUGHAM

generally slide, the front over the back, the hind part of the body being let down to form the footboard. The finish may be open-sided or rustic, solid, and often the top is bent, forming the mudguard as well as giving a pleasing finish. The mounting varies, sometimes elliptic, sometimes side-springs, often in conjunction with a cross spring. Now and then imitation C springs are used.

As an example of bewildering nomenclature of two-wheelers, the following is a selection: Archer, Battlesdean, Canterbury, Cleveland, Concave, Covert, Dagonet, Dalmatian, Empress, Harrington, Kensington, McGorris, Manchester, Morvi, Morgan, Norfolk, Oxford, Poly, Prince, Princess, Princess May, Raleigh, Ralli, Ranmore, Royal, Salisbury, Shooting, Sporting, Stanley, Tynegate, Whitechapel and Wilberforce.

Cabriolets, with graceful, flowing lines, and generally a folding head, carry two persons. The term formerly denoted a special type of hanging. *Tandem carts* are high driving two-wheelers, often with sliding body, and are used as the name indicates. There are many other types, both two and four wheeled, but space will not permit of greater detail. Among foreign types the American platform waggons, curricles, buggies, surreys, concords, and runabouts are quite distinct in general appearance from anything else previously mentioned.

Cycles, in the form of bicycles [8], tricycles, tandems, and other multi-seated types are so familiar as not to require any more than mention

Vehicles for Goods. We now come to the strictly utilitarian type—*goods vehicles.* As in passenger railway work, the bogie has revolutionised the design of goods waggons, and together with the adoption of pressed steel and other frames, an entirely new pattern of useful vehicle is being brought into use [4]. Not only cheaper in haulage and in outlay, but the tare in comparison to the load is in itself a great reason for the adoption of this new stock. Slowly English railways are taking to themselves what has already been long in practice, especially in America. They are called *freight cars;* the large box-cars are specially constructed for carrying furniture, road vehicles fitted up as refrigerators, and for the conveyance of live stock, coke, barrels, etc. The hopper cars carry coal and ore [4], and the low-sided gondola cars have similar uses. Machinery, tramcars, boilers, girders and other large articles have long trucks built for their transport. Our own 10, 15, and 20 ton four-wheeled waggons [6] are a well-known sight on the sidings, and brake, fish and gunpowder vans are also familiar. Tramway companies have their own water, salt, sanding and ticket waggons. *Vans, waggons*, and *carts* mechanically propelled or animal drawn have all specific vehicles designed for the special trade or commodity they are destined to carry.

Trade Cycles and Trucks. The *cycle* as a trade vehicle is seen in the cycle carrier. Butchers, stationers, fruiterers, tailors, and other tradesmen find it quick and economical for the delivery of goods.

One might easily fill a moderate volume with the description and interesting points of *trucks.* We see them as useful adjuncts at railway stations; in the factory they are invaluable; the Post Office places huge orders for them; the baker's barrow, the milkman's perambulator, all have their constructional differences.

Continued

TAILORING FOR GIRLS

Drafting and Making Girl's Box-pleated Skirt. Fastenings, Waistband, and Lining. Drafting & Making Sacque Coat. Measurements & Materials Required

By Mrs. W. H. SMITH and AZÉLINE LEWIS

As the methods employed for making ladies' and girls' clothing are practically the same, we have considered two garments enough for description in this section. If the instructions given in the last portion have been carefully followed, as well as those for boys in the preceding one, the learner should be able to handle successfully any type of coat or skirt.

We will first consider the skirt, for which we have selected a box-pleated model, as this enjoys much favour at the present, and is a graceful and becoming style for walking skirts generally [85]. It requires, however, to be well cut and made, as its smartness depends entirely on the set of the pleats, their accuracy—a most essential point—the hang of the lower edge, good pressing, stitching, and finishing, and all those details which go to the making of a good tailor-made skirt. We cannot, therefore, too strongly insist upon the learner paying very careful attention to these matters, and thus profiting to the utmost from the lessons given in this course.

Box-pleated Skirt. Diagram 86 represents the foundation which we have to work upon to model a pleated skirt.

Measurements. Waist 24 in.; hips (measure taken 5½ in. below waist easily), 36 in.; length, 32 in.; working scale, half-waist, 12 in.; half hips, 18 in. A piece of paper 37 × 43 in. is required.

The short edge of paper must be towards the worker.

The Drafting. Draw a line 1 in. down from top, letter the corner A. A to B, half waist less 1 in. (11 in.). C midway between A and B. A to D, one-fourth of waist plus ½ in. (3½ in.). C to E, ½ in. less than A to D. Curve carefully from D through E to B.

D to F, 5½ in.; D to G, length of skirt (32 in.); F to H, half hip (18 in.) [see broken line]. Draw line from B through H; make I the length of skirt (32 in.); D to J, one-fourth of waist less ½ in. G to K, one-fourth of hip (4½ in.). Now measure down from waist, at equal distances, the length of skirt, to obtain the round for lower edges.

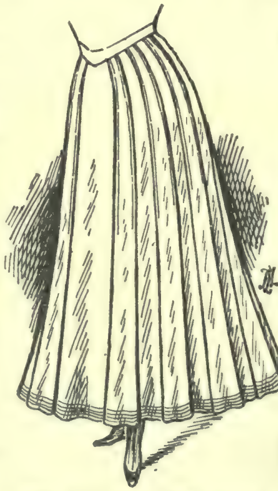
This system applies to all size waists for pleated skirts, and it is an easy matter to make them any length desired.

The directions given are for a panel front. If, however, one prefers the pleats the same distance apart all round, the spaces between the pleats at the bottom must be increased to 4 in., and those at the top to 1 in. Divide the bottom from K into 11 parts, 3½ in. apart, for the width of pleats and spaces between, leaving 1¾ in. from last pleat for centre-back space [86]. This will give six pleats on the half skirt, but any arrangement is possible as to number and width.

The waist must be divided from J to B in the same manner, placing 1 in. for width of pleats, ¾ in. for spaces, and ⅜ in. beyond B, or the actual waist measure (this is to be closed in under the pleats when making).

Draw lines for the pleats as in diagram. The lines on either side of 1 and 2, etc., represent the pleat folded and pressed.

It is advisable first to model the skirt pattern in soft paper, as it will be found easier to work and save a waste of material. For this purpose a very large sheet will be required.



85. BOX-PLEATED SKIRT

Place the paper on the foundation, edge to edge, with the greater length to the left—*i.e.*, above the waist; pin in position. Mark the waist line and the curve at the bottom (both of these will have to be watched throughout the modelling, and marked after each pleat is completed, to ensure their being correct) [87].

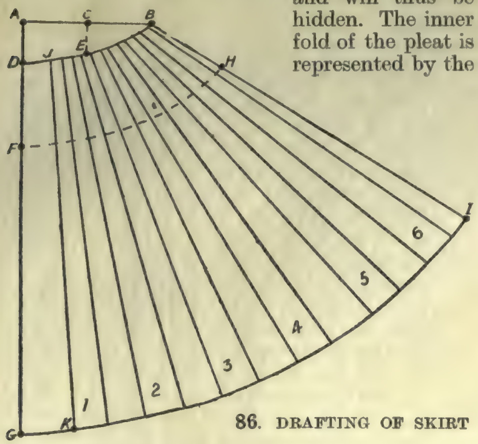
Make J 2½ in. from edge, and K 4½ in. from edge. Draw a line from J to K, K to I, 2½ in. (under part of pleat); J to 2, 1 in. Draw line from 1 to 2 and fold ever to meet J and K. The lines must be drawn in every instance.

1 to 3, 3½ in. (width of pleat); 2 to 4, 1 in.; 4 to 5, the same; 3 to 6, 2½ in.; fold 3 and 4 over to meet 5 and 6. 6 to 7, 3½ in. (space); 5 to 8, ¾ in. Repeat these directions until there are 6 pleats and 5½ spaces.

Perfect accuracy is absolutely necessary to make this skirt a success, both in measuring and in the depth of pleats. Remember to have the waist line and bottom curved to the foundation after the pleats are made.

Cut the pattern up at the double broken lines [87], taking care to put the notches on each gore, as these are placed together when making. A 46 in. material cuts to the best advantage for this length skirt, 3 yds. being sufficient; but for a longer and wider skirt a 54 to 56 in. material will be required. If narrower goods be used the skirt will require more gores, and the

pattern can be arranged with as many as may be wished, provided that each be cut through the fold of the pleat so that the seam comes here and will thus be hidden. The inner fold of the pleat is represented by the



86. DRAFTING OF SKIRT

broken line, and this is where the gores must be cut through. If cut with more gores than those shown in the diagram, care must be taken to number each gore very carefully, and to notch them well, so that the wrong edges shall not be put together, so spoiling the hang and fit of the skirt. It should also be remembered when placing and cutting out that the edges towards the front must be put to the selvedges.

To place the pattern on the material to the best advantage, providing there is no up or down, proceed as follows: Place the cloth on the table with the fold towards the worker. Place the back gore on the left hand, with the bottom $2\frac{1}{2}$ in. from cut edge, and the three notches from $\frac{1}{2}$ to $\frac{3}{4}$ in. (according to the material) from the selvedge; the same amount of turnings must be left on each side of every gore.

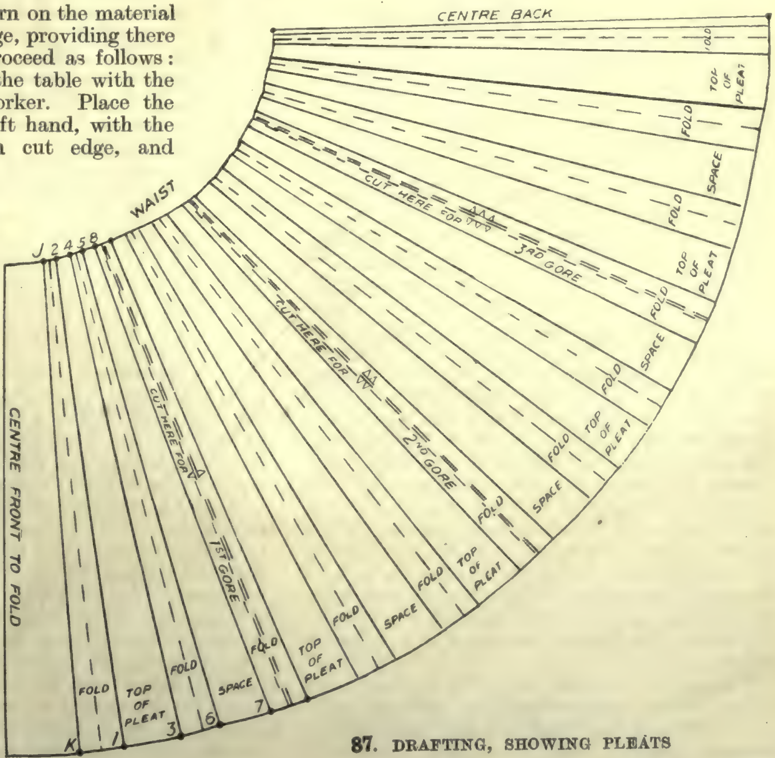
Then place the second side gore with the two notches $\frac{3}{4}$ in. from the fold, and waist to the left. Put the front to the fold, with the bottom $2\frac{1}{2}$ in. from the cut edge on right hand. Now, the bottom of the first gore must be placed 5 in. from the bottom of the second one, to allow $2\frac{1}{2}$ in. for turnings on each; the side with one notch must go $\frac{3}{4}$ in. from the selvedge.

The chalk-marking and measuring for this skirt must be done with the greatest care and accuracy or it will be a failure. No lining is required for a pleated skirt, but a foundation with two or three little frills can be made to wear with it if desired.

Before cutting the material, chalk all round the patterns, also every line on the waist and bottom; then remove the patterns, and with a long ruler or lath (a flat blind-stick answers the purpose very well), draw all the lines as on the patterns. Leave sufficient turnings all round when cutting the various parts.

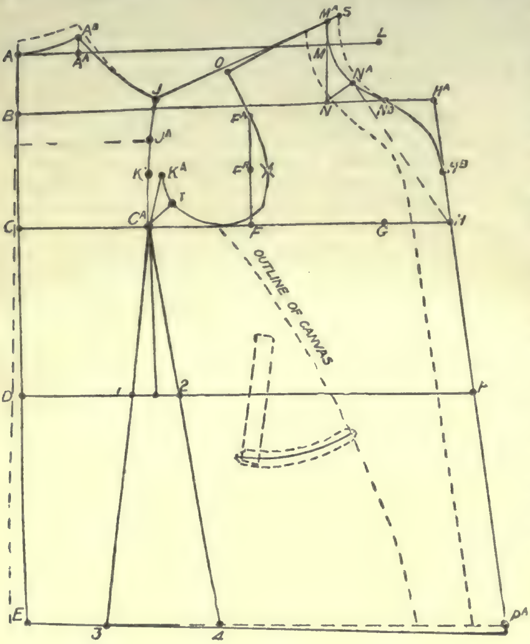
The Making. Then take a needle and cotton and put several stitches along each line and all round. Turn the parts over and chalk-mark; draw lines over the cotton to ensure their being the same on both sides; carefully mark the notches on each gore. Cut and remove the bastings—this should be done in every case to avoid damaging the material. Pin the gores together, keeping the top and bottom even and the notches together; baste carefully and stitch. Remove the bastings, and well press the seams. The raw edges must be loosely overcast. Turn up the bottom to thread-marks, baste, and machine. Remove the basting and press well.

The foot part can be, and in woollen goods more frequently is, faced with lining cut to the same shape as the foot part of skirt, from 4 to 6 in. in depth. This gives a little more substance to the lower edge and allows the



87. DRAFTING, SHOWING PLEATS

stitching to be done much higher up, which is sometimes considered an improvement. In this case, only 1 in. turnings should be left at the bottom, instead of $2\frac{1}{2}$, and $1\frac{1}{2}$ yd. of lining will be required.



88. DRAFTING OF SACQUE JACKET

Fold all the pleats and baste in position. Great care is needed in doing this to keep the pleats perfectly flat and even; they must be well basted on each side. Now stitch each pleat on either side, according to taste—three-quarters of the length is a good depth, graduated to about 7 in. at centre-back. If they are not stitched, they will have to be taped on the wrong side two or three times to keep them in position.

It is advisable to fasten this skirt at the back. A wrap should be put on the left side of opening $1\frac{1}{2}$ in. wide and 9 to $9\frac{1}{2}$ in. long, and a facing on the right side. Both sides should have a linen stay to prevent the edges from stretching, and to act as a foundation for the fasteners, which may be small spring hooks and bars. The wrap should be faced with a piece of silk or lining the same colour as material. The right side should be turned in over the linen stay, and faced with a strip of silk not more than $\frac{3}{4}$ in. wide, or it will interfere with the set of the pleat. Make the bottom of placket opening neat and secure. Stay the waist with a piece of selvedge-wise linen to avoid stretching while pressing the pleats, or the waist will be too large. To press the pleats successfully, a board is required.

Turn the skirt inside out and press each pleat with a cloth slightly damp (not wet) and a hot iron. The iron must be lifted, not moved along, and the pressing done thoroughly. After the pleats are pressed, remove the basting, and, should there be any shine left on the right side as a result, it must be pressed again with a slightly damp cloth and a warm iron over the shiny parts.

Waist Part. The waistband, of double web, must be cut 26 in. long—*i.e.*, 24 in. for waist, $1\frac{1}{2}$ in, for wrap, and $\frac{1}{2}$ in. for turnings. Turn in the ends $\frac{1}{4}$ in. Mark off $1\frac{1}{2}$ in. for the wrap; 12 in. from wrap make a mark for the centre. Place the centre of band to the centre of waist, and baste on, easing the pleats into the band. Try the skirt on, and when satisfactory stitch the band and sew on the fasteners or hooks and bar loops—in any case the band must have hooks and bars. The first one must be put 12 in. from the centre of waist and the second near the end; one hook should be placed $\frac{1}{8}$ inch from the end and the other to fasten in the second bar. Sew on two hangers and the skirt is completed.

[For the finishing of the placket opening see also Dressmaking.]

The Lining. Unlined skirts are now usually provided with a lining in the front breadth, as this prevents any bulging or stretching at the knees, or clinging to the underskirt, which not infrequently happens with a soft material. In this case the lining may be carried down the full length of front, but in the skirt under consideration it would be best to have it only across the panel portion and just below the knees. It must be felled neatly to the pleat of skirt on either side and hemmed at the lower edge. The lining selected should be of a slippery nature—either of silk or glissade—although some of the new mercerised makes of lining answer the purpose almost as well.

Sacque Jacket. Our second model is a sacque jacket for girls from 14 to 16 years of age.

MEASUREMENTS. Neck, $14\frac{1}{2}$ in. Chest, 31 in. Length of back, 15 in. Full length, 25 in. Sleeve from centre-back to elbow, $18\frac{1}{2}$ in. Elbow to wrist, 10 in. Working scale, half-chest ($15\frac{1}{2}$ in.); $\frac{1}{4}$ in. turnings are allowed on all seams.

This pattern will require $1\frac{1}{2}$ yd. of cloth 54 in. wide; $\frac{3}{4}$ yd. canvas; $\frac{3}{4}$ yd. sleeve lining, and $1\frac{1}{2}$ yd. double-width lining.

The Drafting. Square lines at right angles 2 in. down from top of paper and 2 in. in from edge, letter the corner A [88]. A to B, one-sixth of back; B to C, two-thirds of back. A to D, length of back (15 in.). E to E, full length (25 in.). Square lines from B, C, D, and E at right angles.

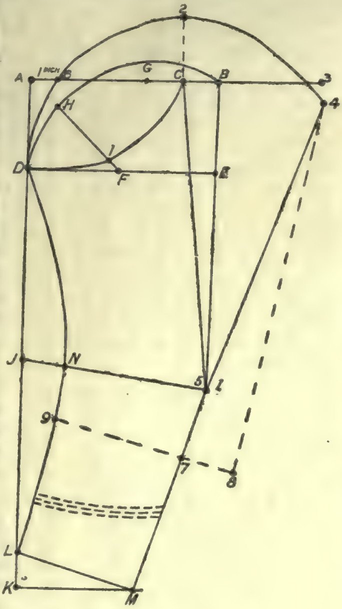
A to A^a, one sixth of neck; A^a to A^b, $\frac{3}{4}$ in.; C to C^a, one-third of chest plus $\frac{1}{2}$ in. (for seams); C to F, two-thirds ($10\frac{1}{4}$ in.); C to G, half chest plus $\frac{1}{4}$ in. ($15\frac{3}{4}$ in.); G to H, three inches; 3 to I, one-twelfth plus $\frac{1}{4}$ in. ($1\frac{5}{8}$ in.).

Square up from C^a to half an inch above B line; make J. J to J^a, 2 in.; C^a to K, 2 in.; K to K^a, $\frac{3}{8}$ in.; F to F^b, one-fourth of chest plus $\frac{3}{4}$ in. (about $4\frac{1}{2}$ in.). F^b, midway between; F^b to X, $\frac{3}{4}$ in. Square up from G to neck line; make L. L to M one-sixth of neck ($2\frac{3}{8}$ in.); M to M^a, 1 in. Square down from M^a to B line; make N.

N to N^a, one-twelfth of neck plus $\frac{1}{4}$ in. (about $1\frac{1}{2}$ in.). Square up from G to B line; make N^b. N^b to H^a $\frac{1}{2}$ in. less than G to H. M^a to O, the same as A^b to J; drop O a quarter of an inch. Draw the neck curves, shoulders, and armholes as in previous drafts. D to P, 1 in. more than C to H. Draw line from H^a through H to P^a for the length of coat. H to H^b, $2\frac{1}{2}$ in.; M^a to S, $\frac{1}{2}$ in.; curve from N^b through N^a to S; connect S to M^a. H^b to S is the neck proper. A to A^b must be raised $\frac{1}{2}$ in. to correspond with front neck, and connected to J [see broken line].

Square down from C^a to waist line, and make a dot. 1 and 2 are each 1 in. to the right and left of this dot. Draw line from C^a through 1, make 3 the length of coat, and from C^a through 2 make 4. Curve from C^a to K^a.

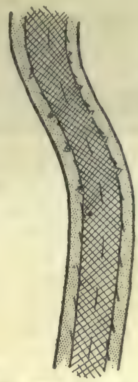
Should the back be required fuller, add 1 to $1\frac{1}{2}$ in., or more, out from E, and draw line to B [see broken line, which must be placed to fold]; drop the front $\frac{1}{2}$ in. and curve from P^a to 3. Any sized jacket can be made from this system.



90. THE SLEEVE

Two pockets are shown on diagram [88], a welted and a jetted—whichever may be preferred—with the making of which we have already dealt.

The broken lines at the back of neck and front represent a trimming of strapping with several rows of stitching, which makes a smart trimming, particularly if it is striped [88]. Another method is a strapping down the centre of back, and from centre of shoulders, back and front. Strapping is very fashionable, and looks well if made half an inch wide and put on to form a design. This model results in a very stylish coat providing it is carefully made. It could have revers if preferred; in this case the front would turn back as from H to N^a [see broken line, 88].



89. THE STRAPPING

Full directions have been given for making coat, revers, etc., in Tailoring for Women. The canvas should be cut (as in diagram 37) one inch beyond F, and taking in the end of the pocket. It should have a facing $2\frac{1}{2}$ in. wide, shaped to the front. For full directions for inserting the canvas, linen stays, facings, and linings, in fact for general making and finishing, refer back to the Making of Boy's Coat. The strappings should be lined with very fine canvas, made and pressed well before putting on [89].

The Sleeve. The sleeve is drafted in the same manner as for Lady's Princess Robe, with a few exceptions [90]. F to 1, $\frac{1}{2}$ in.; C to 2, 3 in.; B to 3, $4\frac{1}{2}$ in.; 3 to 4, $\frac{3}{4}$in.; 4 to 5 must be the same length as 5 to C. This line takes the place of B to 5. A to 6, 1 in. Curve from D through 6 and 2 to 4; this takes the place of D to B and is the top of the sleeve proper. N to 5, one-third of scale plus 1 in.

Should a full three-quarter sleeve be desired, make 7 $3\frac{1}{2}$ in. below 5. 7 to 8, $2\frac{1}{2}$ in. Connect 8 to 4; N to 9, 2 in.; draw line from 8 to 9. This portion should be pleated or gathered into a deep band or gauntlet.

Continued

Group 6
CIVIL SERVICE
17
NATIONAL SERVICE
continued from page 2252

SUBORDINATE CLERKSHIPS

The Position and Prospects of Second Division Clerks. Examinations. Assistant Clerkships

By ERNEST A. CARR

FIRST Class Clerks, as we have seen, form the foremost grade of the general civil staff—that is, they are employed, not in a particular department only, but throughout the service. In the present article and that which follows we shall review in turn each of the remaining appointments on the general staff.

These posts may be arranged in order of value, thus :

Second Division Clerk.
Assistant Clerk or Abstractor.
Officekeeper and Messenger.
Boy Clerk.
Boy Messenger.

Second Division Clerkships. Like the "non-commissioned man" of Kipling's ballad, the Second Division Clerk may fairly claim to be "the backbone of the service." He is, indeed, an element of considerable importance in the general economy of Government business, and in certain respects his rating may not inaptly be compared with that of an army sergeant or sergeant-major. While not enjoying anything like the position or prospects of the Class I. clerk—who is the commissioned officer of the civilian army—he holds distinctly intermediate rank in the public service, is entrusted with somewhat responsible duties, and commands the respectful consideration of his subordinates. Moreover, he has moderate chances of attaining commissioned rank. In two important respects, however, the analogy fails. As a rule, the Second Division clerk is not promoted to that grade, but is appointed to it directly ; and his normal duty is not the instruction or supervision of others, but an executive task of his own.

Second Division clerks are employed in 62 Government offices, and numbered 3,440 in all when last scheduled. Of this total, 391 were then engaged in Dublin, only 111 at Edinburgh, and practically all the remainder in London—that colossal department the General Post Office absorbing no less than 1,136, or about one-third of the whole force.

Duties, Pay, and Prospects. Except for copying and merely mechanical duties, a large proportion of the clerical work of the service is entrusted to these officers. Nominally, their function is restricted to "routine work" ; and in the Post Office and certain other branches the official phrase is a fairly exact description. In many departments, however, they are occupied with involved or confidential tasks to which that definition does not apply at all, and for which their pay is certainly inadequate. In this way, on the other hand, claims to promotion are often established. "The special character of the duties performed" is the reason most frequently assigned for such advancements.

The Second Division clerk may be required to perform temporary duty before receiving a permanent appointment, and during the first year of his service on the establishment is upon probation. His hours of duty are seven daily, with a half holiday weekly or on alternate Saturdays, according to the custom in individual offices. In addition to the usual public holidays, the annual leave for clerks of less than five years' service is fourteen working days, and for their seniors twenty-one working days — that is, three weeks and a half.

Second Division clerks are remunerated as follows. Starting at £70 a year, they advance by £5 annually to £100, and thence by £7 10s. to £190, afterwards progressing by £10 increments to £250, and on entering the higher grade, to £350. Promotion to the higher grade is not automatic, but depends on merit, the regulations providing that although an appointment to this grade shall be made whenever a clerk attains his £250 limit, the promotion will not necessarily be of that particular officer. This provision is by no means a dead letter. It happens not infrequently that an indifferent clerk is left waiting at the £250 barrier, while a more efficient junior, who had not attained that salary, is advanced to the higher grade in his stead.

Another incentive to good work is the recent regulation that a clerk of not less than six years' standing may receive, as a reward for exceptional merit, a special increase of salary not to exceed four annual increments.

Apart from such individual advancements the progress of the Second Division clerk is certainly slow. A simple calculation shows that in the ordinary way his maximum salary is reached only after 34 years. Yet, the certainty of his position, its steadily advancing stipend, and the fair prospects it affords of promotion to the better paid posts, combine to make Second Division clerkships among the most eagerly contested appointments in the national service.

Promotion. The regulations provide that after eight years' service these officers are eligible for advancement to the first class. Hitherto, however, such promotions have been sparingly made, averaging only three or four cases yearly. On the other hand, a number of less valuable staff posts, with salaries ranging from £400 to £750 a year, are reserved for meritorious members of the Second Division. About 30 promotions of this character take

place every year. The proportion of these higher positions differs greatly in the various branches. The Colonial Office, Home Office, and other great administrative departments afford many such openings, while in the Post Office they are conspicuous by their absence. Successful competitors are usually allowed, in order of merit, a certain—or rather, an uncertain—range of choice among the numerous offices. But their selections are necessarily often disregarded, the appointments being determined mainly by the occurrence of vacancies. Candidates should, therefore, recognise clearly at the outset the possibility that they may find themselves, through no fault of their own, practically debarred from advancing beyond the £350 yearly which is the maximum of the Second Division.

To an ambitious officer thus unfortunately placed there is one avenue of advancement always open, at least during the earlier years of his service. He may employ his leisure in studying for one of the examinations by which better-paid appointments are recruited. For this task he will be peculiarly fitted, not only by his previous training, but also by the valuable extension of age allowed (as explained on page 2161) to candidates already in the National service.

The Examination. Open competitions for Second Division clerkships are held once or twice yearly, the number of appointments offered at each varying between 50 and 300, according to the needs of the departments. Candidates must be between 17 and 20 years of age on the first day of the examination, but boy clerks and others who have served for two years or more in a Government office may enter until 22 years old.

The educational scope of these contests corresponds generally with that of an ordinary second grade school. There are, in addition, a few special Civil Service subjects such as few schoolmasters teach. They comprise copying manuscript, précis, and digesting returns. For the first of these exercises the candidate is given a lithographed copy of a badly-written document, so altered and interlined in parts as to be almost undecipherable. Of this he is required to make, in the half-hour at his disposal, a neat and clearly legible transcript, with as few erasures as possible. A little practice with the specimen manuscripts included in former examination papers robs this test of its terrors.

Before starting to write, it is useful to glance down the lithograph, so as to grasp its general purport. Difficult passages are best deciphered by a fairly rapid perusal, as in a really illegible hand the context, rather than a minute study of individual characters, affords the readiest solution to the problems it presents.

The précis subject is more difficult. A number of printed letters and papers relating to some official matter is handed to the competitor. After reading these he must prepare an index giving the date of each document, the persons between whom it passed, and a brief and distinct statement of its subject-matter. He must then write a précis or summary, in the form of a continuous narrative, of the whole correspondence, so that a perusal of the précis would place anyone in possession of all the leading features of what had passed. The merits of such a summary, in official phraseology, are: "(*a*) to include all that is important in the correspondence; (*b*) to present this in a consecutive and readable shape, expressed as distinctly as possible, and as briefly as is compatible with distinctness."

The index should first be written, letter by letter, avoiding wordy, indirect phrasing, and taking care to omit from the summary mere side-issues and unimportant details in the documents. A "wrinkle" worth noting is that in official correspondence an admirable summary of a letter may often be found in the reply to it. Thus, the answer frequently runs: "Referring to your letter informing me that——" the rest of the sentence recapitulating in a few terse expressions the purport of the communication referred to. The student should keep a sharp look-out in the examination-room for such legitimate aids to indexing as may be furnished in this way by the correspondence itself. If the index be carefully done, the précis will become a fairly simple task.

Digesting Returns into Summaries. This quaintly named subject is a simple test of the clerkly qualities of neatness, care, and accuracy of calculation. Candidates are required to rule a form of statistical table like that given in their examination papers, to insert the various column headings, and finally to fill in the columns from printed particulars supplied. The task is never one of mere transcription, but involves always some rearrangement and mathematical work, such as the calculation of percentages, the substitution of kilogrammes for English weights, or the conversion of pounds sterling into marks or francs.

No special difficulty is presented by any of these exercises, yet in each case some preliminary practice is essential in order to complete the paper within the allotted time and to avoid mistakes; for as they are tests of exactness, every mistake, even though corrected, involves a loss of marks. Elementary as they are, the student cannot afford to neglect them. He may generally ensure sufficient practice in them by attending for a term or so one of the day or evening classes for the Civil Service to be found in almost every town.

"Tots." The arithmetic test in these competitions includes a special paper that merits the particular attention of candidates. This is the "tots" paper—a familiar feature of Civil Service examinations, and a simple trial of speed and precision. Candidates are given a printed set of exercises in addition, some having the figures arranged in vertical and others in horizontal columns. The *totals* of these figures have to be inserted in the form itself; hence the students' slang term "tots." Simple as the paper is, candidates who have not accustomed themselves to work accurately at top speed are certain to lose marks for errors or for failing to finish the exercise. On the other hand, steady

practice will enable almost any student to ensure obtaining full marks.

The full list of examination subjects for Second Division clerkships, the maximum for each, and the actual marks obtained by the first and last successful candidates at a recent contest, are shown in the following table. It should be noticed that of the 11 papers only 7 may be taken, including not more than two languages; and further, that although no subject is obligatory, the competition is so keen that a candidate who took less than the full number permitted would not have the slightest chance of success. At this examination 1,197 students competed for only 70 places, an abnormally high proportion of candidates to vacancies.

EXAMINATION FOR SECOND DIVISION CLERKSHIPS

Order of Merit.	Service Marks.	Handwriting, Orthography, and Copying Manuscript.	Arithmetic.	English Composition.	Not more than Four to be Taken. Précis, Indexing, and Digest of Returns.	Bookkeeping and Shorthand.	Geography and English History.	Two only may be taken. Latin.	French.	German.	Elementary Mathematics.	Chemistry and Physics.	Total.
Max.	—	600	600	600	400	400	400	400	400	400	400	400	3400
1	—	518	510	450	—	—	353	289	308	—	305	—	2733
70	—	532	485	387	296	—	207	—	247	—	210	—	2364

Service Marks. A curious feature of these competitions is the allowance of special marks, proportionate to their term of service, to candidates who have been employed in Government offices as boy clerks. Thus 20 "service marks" are given for a year's service, 60 for two years, and the maximum of 120 is secured by three or more years' employment. These form very substantial additions to the examination total. For instance, in the competition to which our table of marks relates, no fewer than 16 successful candidates owed their good fortune to service marks.

Assistant Clerkships. The post of assistant clerk or abstractor, which has replaced the wretchedly paid and now obsolete rank of man copyist, offers few attractions beyond permanent employment and a slowly progressive salary. Its mechanical duties are repaid by a salary less than that of any other office on the permanent clerical staff. On the other hand, this grade is recruited wholly from the ranks of former boy clerks who have lacked the energy, ability, or fortune to secure better positions in the Second Division or elsewhere. The pay of assistant clerks, commencing at £55 a year, rises by £5 annually to £150, subject to a special certificate of efficiency at £100. They are allowed 14 days' annual leave, and after 10 years' service this becomes 18 days. They may be promoted to the Second Division, on the ground of special merit, after not less than six years' duty, and a considerable proportion of the total number are so promoted, in fact; but beyond this their prospects of advancement are of the scantiest.

Examinations. Examinations for assistant clerkships are held twice a year, usually in February and July. Candidates must be between 19 and 21 years of age on January 1st or July 1st of the year in which they compete, and must have actually served as boy clerks (or in the now almost extinct grade of boy copyists) for two years if their service commenced before the age of 17½, or for one year if it began after that age. The subjects of examination are five in number—namely:

1. English composition (including handwriting and spelling).
2. Arithmetic (to vulgar and decimal fractions).
3. Digesting returns.
4. Précis and indexing.
5. Shorthand and bookkeeping.

Competitors whose total marks do not indicate "a competent amount of general proficiency" are disqualified from receiving appointments. This standard has latterly been fixed at 1,000 marks in a maximum of 1,900.

At each examination about 100 vacancies are contested by three or four times that number of aspirants. As one-third of these, however, usually fail to attain the qualifying standard of marks, the *effective* competition is seldom much in excess of two candidates for each post. The great majority of assistant clerks are employed in London.

Poor as the appointments are in themselves, they are useful to ambitious and resolute young men who find it necessary, after serving as boy clerks, to earn a living wage while preparing for better positions. Among the present writer's official acquaintances, for instance, are two ex-abstractors, one of whom receives £550 a year, and the other £400 with a certain prospect of £650. But these are exceptional cases, and for men of average abilities there is a danger lest an assistant clerkship, adopted in the first instance as a merely temporary footing in the service, should be accepted at last as the "be-all and the end-all" of an official career.

Continued

LAUNDRY WORK

Utensils Required for Washing, Mangling, and Drying. Ironing Implements. The Preparation of Water, Borax, Soda, Soaps, etc.

Continued from page 2336

By ALICE E. MARSHALL

LAUNDRY work is a subject affecting every household, and ranking among the most important of the domestic sciences. The matter is one of no little importance to every home, directly or indirectly, and we shall, therefore, deal with it in the most thorough and practical way possible in such a course.

Laundry Utensils. Taking the various phases of laundry work in their natural sequence, we shall, in the first place, deal with the requisite utensils.

THE BOILER OR COPPER. The boiler is generally a fixture, and is made of copper or iron, heated by gas or by a fire underneath. The former method of heating is coming more into general use, and is certainly cleanly and easily managed. The boiler must be kept perfectly clean and free from dust and dirt, being washed and dried well each time after use, otherwise there is a danger of the clothes becoming stained. A little washing-soda dissolved in hot water will remove any scum which may have adhered to the sides; or soap and powdered bath-brick may be used with like effect.

WASHING MACHINES. Washing machines lighten the labour. They are of various kinds; one combining washing, wringing, and mangling is excellent, though somewhat expensive, costing about £5 [1].

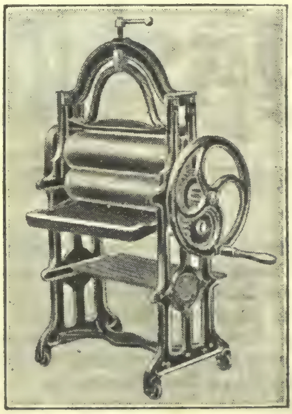
THE WRINGER. A wringer is used sometimes in place of the mangle; this does not press the clothes, but only helps to remove the water. It may be bought as a separate article or fixed to a tub. The rollers are of indiarubber, and nothing very hot must be placed between them, or the rubber may crack. A cloth that has been dipped in an equal quantity of turpentine and water and then wrung out is useful for wiping the rollers occasionally. It helps to keep them soft and also removes any grease. A wringer costs about £1.

THE DOLLY-TUB AND "POSSER." A dolly-tub [3] and "posser," or dolly-legs, will be needed for large things, such as sheets, which do not require much rubbing. The tub is made of wooden staves, bound together with iron bands. No nails are used in its manufacture; so care must be taken not to let it get dry, or it may fall to pieces. A little clean water should be left in the bottom when the tub is not in use. The "posser" is an American invention, and acts by suction. It is worked up and down in the tub, and draws the water through the clothes, thus freeing them from dirt.

The "dolly-legs" answer the same purpose, but are much heavier to use, and more unwieldy; with the tub, however, they save a great amount of labour which would otherwise be necessary in rubbing the clothes [4].

1. WASHING, WRINGING, AND MANGLING MACHINE

3. DOLLY-TUB



2. MANGLE

THE MANGLE. This is useful for wringing and pressing clothes. A good make—we should not advise the purchase of any other—may be bought for £3. It saves a great deal of labour in wringing the clothes, and should, of course, be kept very clean. A cover should be thrown over it when it is not in use, and the screw must be loosened to relieve the pressure on the rollers; while the wheels need to be oiled occasionally in order to make it work easily [2].

THE CLOTHES-HORSE. A clothes-horse will be required, and a wooden rack is also desirable. The latter should be suspended from the ceiling, and will be found invaluable in drying and airing clothes. The wood of both "horse" and rack must be hard and well-seasoned, or it will stain the linen [5].

LINES AND PEGS. These are necessary for outdoor drying; they should be brought indoors as soon as the clothes are dried and kept in a bag when not in use. They may be boiled in the copper occasionally. Pegs should be made entirely of wood, without a tin band, as the tin will sometimes cause a stain when the clothes are wet [6].

A CLOTHES BASKET.

ZINC BATHS. Two or three zinc baths for washing purposes are also needed; these do not rust, and they have the advantage of being much lighter to lift than those made of wood or earthenware.

BOWLS. One or two papier-mâche bowls may be included in the outfit; they are particularly useful for small things, such as collars and laces, and though rather expensive—costing about 2s. 9d. each—they repay the outlay by being practically indestructible. With the mention of two wooden sticks for use in the boiler, we may leave the washing utensils.

Ironing Implements. We have now to consider the "implements" used in ironing.

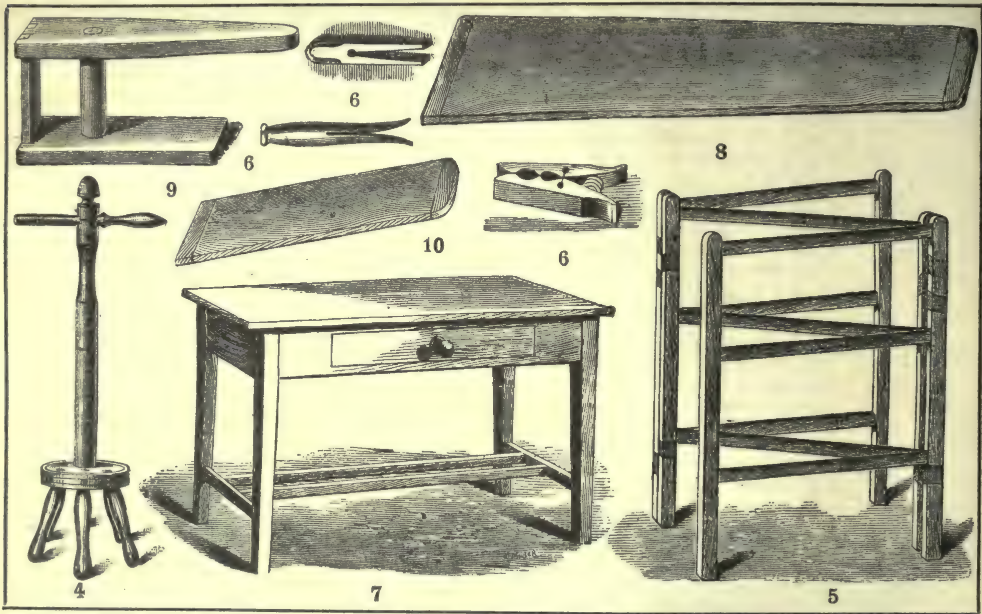
THE TABLE. This is of the utmost importance; it should be fairly long, and not less than 3ft. wide, steady, and with an even surface. Anyone who has ironed on a table with one short leg, or with two or three cracks in the top knows the discomfort produced. It must not be too high, as pressure is required, and this is impossible when the arm has to be raised; neither should it be too low [7].

THE SKIRT, SLEEVE, AND SHIRT BOARDS. These are aids in ironing, though they may be dispensed with. A local joiner will make any of them at a small cost. The skirt board is generally about 5 ft. long by 1½ ft. wide, narrowing a little at one end. This is inserted in the skirt, the ends of the board resting on two tables, a cloth or paper being placed on the floor underneath to prevent the skirt from getting soiled [8].

A sleeve board is similar in shape, but about the size of an ordinary shirt sleeve [9].

A shirt board is used in ironing the front of men's shirts, the usual size being about 16 in. long by 10 in. wide [10]. All the boards should be covered with felt or flannel, tacked together at the back of the board, and should then have clean white covers slipped over them, and tied on tightly with tapes. The ironing table must also be covered with felt or blanket, without any seams or joins, and over this a clean cotton cover, which should be tied down tightly at each corner, any "ruckling" being very undesirable whilst ironing. The felt may be bought for about 9d. per yard.

IRONS. These are of various kinds—flat [11], box, gas, charcoal, etc. The two latter retain the heat longest, but some people object to the fumes which come from them. Flat irons are excellent to use if heated by gas, or on a closed stove; but it is almost impossible to keep them sufficiently clean for ironing starched things if heated in front of the fire. When the fire has to be used for heating purposes, the box-iron is preferable. A good fire must be kept up for the heaters. Irons should never be put on the fire, as this spoils the temper of the steel. Other irons used are polishing [12], goffering, crimping, etc., all of which are useful in giving a nice finish to the work, but are not absolutely necessary.



4. DOLLY-LEGS 5. CLOTHES HORSE 6. PEGS 7. TABLE 8. SKIRT BOARD 9. SLEEVE BOARD 10. SHIRT BOARD

To clean the irons, wash them occasionally with soda and hot water, dry them well, rub them on a board sprinkled with bathbrick, and dust them thoroughly each time before use. When not in use, smear them with vaseline or mutton fat to prevent rust.

Materials. WATER. Among the materials used for laundry purposes water is the first consideration. This is, of course, of two kinds—hard and soft—and the degree of hardness may be determined by the amount of soap solution required in order to obtain a lather. Londoners are conscious of a difficulty in this respect. Rain-water is the purest form and the best for washing purposes; it dissolves soap readily, and is therefore economical. Work is much more quickly done when it is used, for as a cleansing agent the soap comes into action at once, and there is therefore no waste. In the country the rain-water can be collected for use; but in towns and cities the soot and organic matter render it useless for laundry purposes. Next in value to rain-water comes that from rivers and streams, and some river water is, indeed, as soft as rain-water. Spring and well water are the hardest. All hard water contains to a greater or lesser extent mineral salts, which it has taken up in its passage through the earth. Hard water has a peculiar effect on soap, which it curdles and makes into a substance known as "lime soap." This is easily recognised as the dirty scum which floats on the top of the water, and until sufficient soap has been added to overcome this hardness and form a lather, the water is unfit for washing purposes.

11. FLAT IRON

The softening of water may be brought about in different ways:

By exposure to the air, as in the case of reservoirs.

By boiling, when the lime becomes deposited.

By the addition of some softening agent, such as soda or borax.

The latter method is the one generally employed, as it is the easiest and the least expensive.

BORAX. This is much less harmful than soda, but is not so powerful in its action. One tablespoonful of powdered borax may be added to two gallons of hard water, but the borax must be previously dissolved in boiling water. Borax has the properties of:

Softening hard water, giving a gloss to linen, acting on grease.

It does no harm to colour or material, and is inexpensive, costing about 2d. per lb.

SODA. This is a powerful alkali, chiefly obtained from common salt. It is a valuable cleansing agent, but requires to be used with great care, as it may destroy the colour and texture of any material with which it comes in contact. Soda should never be used for woollen clothes; it makes them yellow, hard, and less elastic. It should always be dissolved in boiling water before use. If a small piece settles on the clothes it causes brown stains to appear, which afterwards break into holes. For washing very dirty materials, such as oven cloths, it may be used with advantage, as it softens the water and acts on the dirt, assisting greatly in its removal. Add a piece of soda about the size of a walnut to two gallons of water, first dissolving the soda in boiling water. Soda should be kept in a covered jar in a dry place, or it will waste and lose its strength.

Washing powders should never be used for coloured materials.

SOAP. Soap is a chemical compound of fat and soda or potash, with the addition of resin. Soda is the alkali used in hard soap, and potash in soft soap. The latter is very powerful in its effects, and should be but rarely used.

12. POLISHING IRON

The combination of fat with soda in soap neutralises the caustic effects of the latter, the two together, with the addition of resin, forming soap. Of this there are many varieties. The cheaper kinds generally contain an excess of alkali and water. The best for laundry purposes is the ordinary yellow soap. This should be bought from a reliable firm, in fairly large quantities, if possible, and should then be cut in convenient sized pieces, and stored away in a dry place, so that it may harden. New soap is very wasteful. The average cost of soap is about 3d. per lb., but it can be had cheaper if bought in large quantities.

AMMONIA. In its liquid form ammonia is very useful in laundry work. It softens hard water, acts on grease, and is generally used in the washing of woollens. With melted soap and warm water it forms a soft lather; the garments are quickly cleansed, and their soft woollen nature is retained. Ammonia, being of a volatile nature, should be kept in a tightly-corked bottle, and be labelled "Poison." Before washing-day, the stores should be examined to see that all requisites are at hand.

BLUE. This will be required to tint the clothes.

SALT and VINEGAR for coloured materials.

STARCH, WAX, and TURPENTINE for stiffening purposes.

GUM ARABIC to stiffen silks, etc.

MELTED SOAP for flannels and prints, etc. This should be prepared by shredding some soap (the odd pieces can be used up) into a pan, covering it with cold water, and allowing it to dissolve slowly by the side of the fire; then pour it into a jar, and it is ready for use.

Continued

Continued from page 2288

A SHORT HISTORY OF ART

A Survey of the Beginnings and Evolution of Art through all Ages: Stone and Bronze Ages, and the Influence of Religion on Early Art

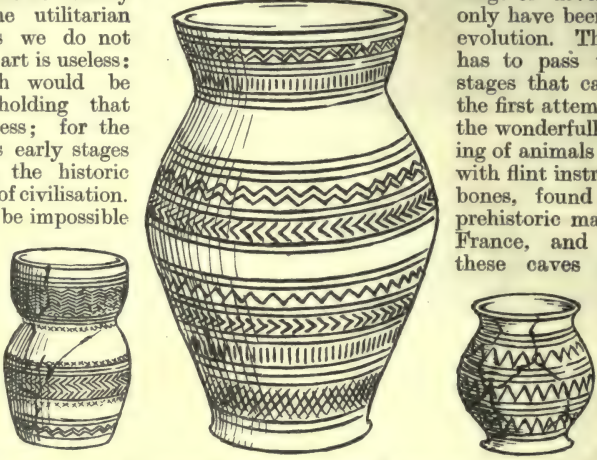
By P. G. KONODY

THE origin of art is shrouded in the impenetrable veil of the unknown past. To trace the earliest manifestations of the artistic instinct belongs more to the sphere of the geologist than to that of the historian; and it is indeed difficult, if not impossible, to define the beginning of the artistic functions of prehistoric man. But it seems fairly obvious that the exercise of the artistic function must be strictly separated from the utilitarian principle. By this we do not mean to imply that art is useless: to maintain which would be equivalent to upholding that civilisation is useless; for the history of art, in its early stages more than during the historic period, is the history of civilisation.

Civilisation would be impossible without the establishment of human communities, and art is essentially a manifestation of the social instinct which leads to the formation of communities. When the cave-dweller of Perigord and of the Pyrenees chipped his axes and spearheads out of flint, his object was entirely utilitarian; but when he tried to give them as symmetrical a shape as was in his power [2], and began to decorate them with simple ornaments—more so still when he painted his body with ochre—his motives were of a social character: he did this to please the eye of his fellow-man; and here we have the first manifestations of art. When prehistoric man at a later period shaped his first earthenware vessels, his object was utilitarian; when he adorned them with zig-zag lines and patterns scratched into the clay, he was actuated by the art instinct.

The Beginnings of Art. There can be little doubt that personal adornment gave the man of the Quaternary period his first scope for the exercise of art, if we use the word in its widest sense. He wanted to increase his personal attractiveness, and what in the lower stages of organic life is wrought by sexual selection had thus become a conscious function of the human mind. And considering the matter from this point of view, we lose again the demarcation line between the utilitarian and the artistic principles.

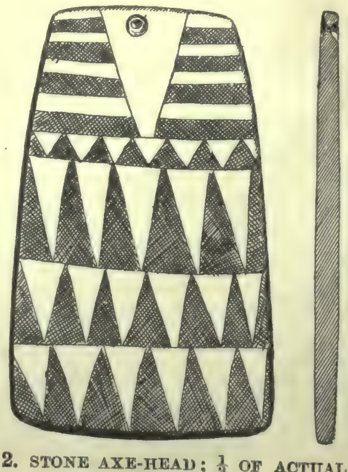
Where art is first met in an unmistakable and clear form, it reveals to us a comparatively high stage of development which can only have been the result of slow evolution. The art of a nation has to pass through the same stages that can be observed in the first attempts of a child; but the wonderfully realistic rendering of animals in motion, incised with flint instruments on reindeer bones, found in the caves of prehistoric man in England and France, and on the walls of these caves [see page 2256], have little in common with the childish stuttering of an infant's first pictorial attempts. They are rather the scarce remains of a primitive civilisation, dating 12,000 to 14,000 years back, which was followed by an age of decadence setting in approximately with the disappearance of the reindeer from this region [3–6].



1. DRINKING CUPS (*British Museum*)

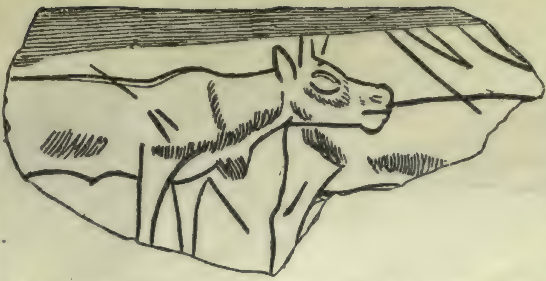
So faultless are some of these early representations of animals as regards clear delineation, expression of varied movement, bold simplification, suppression of detail, and grasp of all that is really essential, that these early attempts will lose nothing by being placed beside the sketches of the most competent and advanced of modern artists. And as the scratching of these outlines on bone mark the first attempts at drawing, so in the filling in of the contour with earth colours may be discovered the first stage of the art of painting.

The child, in its attempts at drawing passes from merely ornamental line to animal and, finally, to human forms. The



2. STONE AXE-HEAD; $\frac{1}{3}$ OF ACTUAL SIZE (*British Museum*)

artist of the Quaternary period never passed beyond the second stage. He would depict animals on his implements, scratch them upon the walls of his cave dwellings, incise them on reindeer bones, and carve them in bone and horn; but he never advanced to the representation of the human figure. This achievement was left to a later civilisation, which had its origin in the East—in the valleys of the Nile and the Euphrates, in India and in China, and of which we shall have to speak later.



3. BONE ENGRAVING OF REINDEER, LA MADELAINE

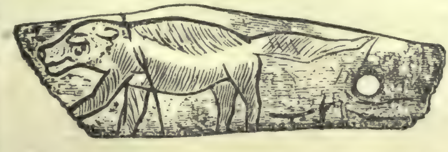
(*British Museum*)

The Stone Age. If what may be termed "pictorial art" appears to us in an advanced form in these remote ages, monumental sculpture and architecture can be traced from their very earliest beginnings. The simplest and earliest form (earliest not as regards actual date, but as regards development; the polished-stone age and bronze period of Northern Europe coincide with the flourishing of a very high civilisation in Egypt, which had its prehistoric period several thousand years earlier) is the artificially raised burial mound, or tumulus, or a mighty rude block of stone, or menhir, erected in memory of some fallen hero or great event. The single stone block can scarcely be described as a work of art, though at times it was ornamented with geometrical designs, and even carved into an approximate semblance of a human being; but the artistic intention becomes clearly perceptible when the stones are planted into the ground in rows at regular intervals to form a pattern, as can be seen at Carnac in Brittany. The table-like altars at Stonehenge mark a further development [7]. Flat stone blocks are laid on to two to four upright stone supports of equal height, which have the function of walls or pillars, as the case may be, and thus for the first time introduce an architectural motif. To a little later period belong the lacustrine dwellings, about 3500 B.C. These were wooden buildings erected on piles driven into the mud at the shores of the Swiss and French lakes—the first buildings, properly speaking, and a great step forward from the cave dwellings of the Quaternary races. Now polished stone had taken the place of chipped flint, and rude pottery was extensively used; but no specimens of "pictorial" art, like the incised bones of Perigord, have been found among the remains buried in the mud of the lakes [1].

4. IBEX HEAD; $\frac{2}{3}$ OF ACTUAL SIZE

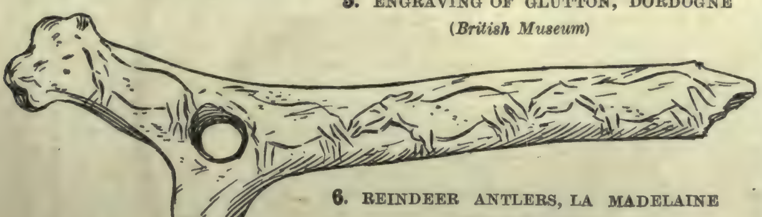
(*British Museum*)

The Bronze Age. The Stone Age passed into the Bronze Age. Exactly when this great step towards civilisation was taken cannot be established with any degree of certainty; but it is very probable that the knowledge of the use of metals was brought to central and northern Europe by the Phœnicians, and that the lacustrine dwellers shaped ornaments of gold and objects of copper before they had learnt how to produce bronze by fusing copper and tin. Innumerable articles for personal adornment and for daily use that have been brought to the light from the lake dwellings and burial places of Great Britain, France, Germany, Switzerland, and Scandinavia have a distinct claim to be considered as works of art, since many of them are wrought into exquisite shapes, and moreover, profusely decorated with ornamental design —spiral, circular and curved lines, in faultlessly symmetrical arrangement. The ornamentation is either incised or welded on to the body of the object. But with all his skill of craftsmanship, taste in design and inventiveness, man of the bronze period never attained to the artistry of that much earlier period to which belong the wonderful representations of animals carved on bone with rude flint implements by the contemporary of the mammoth and the reindeer [8]. It is extraordinary that he did not rise to the



5. ENGRAVING OF GLUTTON, DORDOGNE

(*British Museum*)



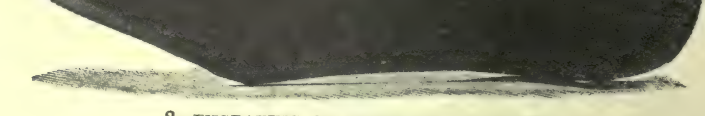
6. REINDEER ANTLERS, LA MADELAINE

(*British Museum*)

7. STONEHENGE *Valentine*

imitation of the forms of nature, and restricted himself to the abstract invention of ornament. The reason for it may perhaps be found in some religious superstition which forbade the representation of man and beast and plant; perhaps some severe law like that of the ancient Jews, which placed God's creation beyond the pale of art.

Influence of Religion on Art. Altogether it is impossible to lay too much stress on the influence of religion on art from the dawn of civilisation to the end of the Middle Ages. Religious belief, the worship of the dead, and of the mysterious powers that rule human life, the desire to give tangible expression to the vague mysteries of religion, to create symbols for the idea of the invisible forces that shape human destinies, were ever the most powerful religion and to superstition—to the desire to pacify the invisible powers and to honour the dead, or rather to secure their intercession with the dreaded powers. And the first expressions of the artistic instinct are akin in all parts of the globe. They can be traced among the Celts and Scandinavians, and the South Sea Islanders, on the shores of the Mississippi and in the heart of Asia, though, of course, the dawning of the artistic intellect appeared at different periods in the different parts of the world. Thus the civilisation, or rather the art, found by the Spanish conquerors in the lands of the Incas and the Aztecs was in many respects similar to that of the Egyptians 3,000 years before Christ; and the present day aborigines of some Polynesian islands have not yet achieved the civilisation of the Celtic period



8. ENGRAVING OF MAMMOTH ON BONE
(*From Cast in British Museum*)

stimulants for the creation of art. Perhaps the very scratchings on reindeer bones and on the walls of the caves owed their origin to some religious superstition. The dolmens and menhirs, the whole early pictorial and plastic art of Egypt, the grotesque images carved in stone by the South Sea Islanders, and by the ancient Peruvians and Mexicans, are inspired by the religious beliefs of their makers. In fact, all early manifestations of art owe their origin to in Europe. It is for this reason that the introductory chapter of our survey of the world's art in its logical sequence takes us to Europe at a time about 1000 B.C., whilst Egypt had already passed through the great period of her civilisation. In northern Europe we are still in the primitive, prehistoric age, whilst in the East, history has been made, and mighty Empires have risen and fallen into decay.

Continued

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SPANISH

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By Amalia de Alberti

ADJECTIVES

Adjectives agree in gender and number with the nouns they qualify.

Adjectives are of two classes: those that have a termination for each gender, as: *blanco*, white, fem. *blanca*; and those that have only one termination for both genders, as: *grande*, great; *vil*, vile.

Formation of the Feminine. All adjectives ending in *o* change the *o* to *a* in the feminine—example: *hermoso*, beautiful, fem. *hermosa*.

As a general rule adjectives ending in a consonant have the same ending in both genders, as: *un hombre feliz*, a happy man; *una mujer feliz*, a happy woman.

The following adjectives ending in a consonant are exceptions to this rule and take an *a* in the feminine.

Adjectives ending in *on* or *an*, as: *holgazan*, lazy, fem. *holgazana*; *bribon*, thievish, fem. *bribona*.

Adjectives ending in *or*, as: *traidor*, treacherous, fem. *traidora*; except: *inferior*, inferior; *superior*, superior; *mayor*, bigger; *mejor*, better; *peor*, worse; *anterior*, anterior; *posterior*, posterior; and *ulterior*, ulterior; which are invariable.

Adjectives of nationality take an *a* in the feminine; those ending in *a* are the same in both genders.

inglés, English, *inglesa*
español, Spanish, *española*
frances, French, *francesa*
persa, Persian, *persa*

NOTE. Adjectives of nationality do not require a capital letter in Spanish.

Formation of the Plural. Adjectives, ending in an unaccented vowel take an *s* in the plural.

mas. *feo*, ugly, pl. *feos*
fem. *fea* pl. *feas*

Adjectives ending in accented vowels or consonants take *es* in the plural; those ending in *z* change the *z* into *ces*, thus: *cortes*, courteous, pl. *corteses*; *carmesí*, crimson, pl. *carmesíes*; *feliz*, happy, pl. *felices*.

General Remarks on Adjectives. Almost any adjective in Spanish can be used as a noun, and become subject to all the rules governing nouns, as: *traidor*, treacherous; *un traidor*, a traitor; *inglés*, English; *un inglés*, an Englishman.

The following eight adjectives lose the final *o* in the singular before a musculine substantive: *Alguno*, some; *bueno*, good; *malo*, bad; *uno*, one; *primero*, first; *tercero*, third; *postrero*, last; thus: *un buen amo*, a good master; *el primer hombre*, the first man; *un rey*, one king; *algun dia*, some day. The adjective *santo* (holy) loses the final syllable before the names of all saints except Saint Dominic, Saint Thomas, and Saint Toribius, as: *San Pedro*, Saint Peter; *San Pablo*, Saint Paul; *Santo Tomas*, or *Tomé*, Saint Thomas; *Santo Domingo*, Saint Dominic. When the island of St. Thomas is meant the last syllable is not retained.

Ciento, a hundred, loses the last syllable before substantives and adjectives, but retains it in every other case, as: *cien hombres*, a hundred men; *ciento y uno*, a hundred and one.

Grande, great, when it signifies excellence, loses the last syllable and precedes the noun, unless the latter begins with a vowel, as: *un gran poeta*, a great poet; *una grande amistad*, a great friendship. When it signifies size or extent, it is placed after the noun, thus; *una mesa grande*, a large table; *un campo grande*, a large field.

Vocabulary	**Vocabulario**
The cows	Las vacas
The bulls	Los toros
The heifers, calves	Las terneras
The horses	Los caballos
The mares	Las yeguas
The colt	El potro
An ass	Un burro
A she-ass	Una burra
A mule	Una mula, (mas.) mulo
The farmer	El hacendado
The farm hands	Los labradores
The poultry yard	El corral
The cock	El gallo
The hens	Las gallinas
The chickens	Los polluelos
A goose	Un ganso
The ducks	Los patos
The dairy	La lecheria
The milk	La leche
The butter	La manteca
The cheese	El queso
The eggs	Los huevos
The sportsman	El cazador
The game	La caza
The rabbits	Los conejos
The hares	Las liebres
The partridges	Las perdices
The young partridges	Los perdigones
The pheasants	Los faisanes
The deer	Los ciervos
The bears	Los osos
The boars	Los jabalies

The wolves	Los lobos
The setters	Los perros de muestra
The gamekeeper	El guardo
Stockings	Medias
Shoes	Zapatos
Braces	Tirantes
A flannel vest	Una camiseta
A shawl	Un pañolon
Socks	Calcetines
A shirt	Una camisa de hombre
A collar	Un cuello
A suit	Un terno
A cravat	Una corbata
Gloves	Guantes
Cuffs	Puños
An overcoat	Un paletó
A frockcoat	Una levita
The slippers	Las chinelas
The tailor	El sastre
The dressmaker	La costurera
The milliner	La modista
The glover	El guantero
A glove shop	La guanteria
Good morning	Buenos dias
Good night	Buenas noches
Sir	Señor
Madam	Señora
The school	La escuela
The college	El colegio
The master	El maestro
The mistress	La maestra
The studies	Los estudios
Grammar	La gramática
Geography	La geografia
History	La historia
Scripture history	La historia sagrada
Mathematics	Las matemáticas
Algebra	La álgebra
Geometry	La geometria
Languages	Los idiomas
Spanish	El español
French	El frances
English	El ingles
German	El aleman
Latin	El latin
Greek	El griego
The classics	Los clásicos
The Latin race	La raza latina
The Saxon race	La raza sajonia
The examinations	Los examenes
The examiner	El examinador
The prizes	Los premios
A scholarship	Una beca
The library	La librería
The books	Los libros
The manuscripts	Los manuscritos
The ink	La tinta
The paper	El papel
The blotting paper	El papel secante
London	Londres
Paris	Paris
Madrid	Madrid
Berlin	Berlin
Vienna	Viena
St. Petersburg	San Petersburgo
Pekin	Pekin
New York	Nueva York
Rome	Roma

EXERCISE IV.

Translate the following into Spanish:

1. That man is tall and that woman is tall[2]
Ese . . . . esa . . . .
also[1]. 2. That building is beautiful, and that
tambien . . . . edificio . . . .
statue is beautiful. 3. A traitor to his country.
estatua . . . . á su patria
A traitress to her faith. 4. A Spaniard, a
. . . .
Spanish woman, an Englishman and an English
. . . .
woman talked without understanding [one
. . . . . hablaban sin . . entenderse . . . . .
another]. 5. A good[2] master[1] and a good servant
. . . .
are rare. 6. The farm is productive. 7. The
. . raros . . . . productiva . . . . . .
bulls are wild. 8. The colts are numerous.
. . . . . . bravos . . . . numerosos.
9. The mules are strong. 10. The farmer is
. . . . fuertes . . . .
rich. 11. The labourers are honest. 12. The
. . . . honrados . . . . .
cock crows in the morning; the hens cackle.
. . . canta por la mañana . . . . . cacarean.
13. The milk and the butter are fresh. 14. The
. . . . frescas . . . . .
sportsman is [a] good shot. 15. The game is
. . . . tirador . . . .
abundant. 16. The deer are swift. 17. The
abundante . . . . ligeros . . . . .
bears and the boars are fierce. 18. The game-
. . . . feroces . . . .
keeper is vigilant. 19. The stockings are of
. . . . . . vigilante . . . .
silk and the shoes of fine[2] leather[1]. 20. The
seda . . . . piel fina . . . .
shawl is of wool, and so also are the socks.
. . . . lana, ... lo son . . . .
21. The gloves are of dog's skin. 22. The tailor
. . . . piel de perro . . . .
has brought my overcoat and my frock coat.
ha traido mi . . . .
23. The dressmaker has brought my dress.
. . . .
24. The milliner has brought my hat, and the
. . . .
glover my gloves. 25. Good morning, sir!
. . . . mis . . . .
Good morning, madam! 26. The college is
. . . .
good. 27. It has a beautiful[2] library[1] and
. . . .
splendid[2] books.[1] 28. The manuscripts are old.
splendidos . . . .

PROSE EXTRACT IV.

FROM "DON QUIJOTE," BY MIGUEL DE CERVANTES.

DON QUIXOTE AND THE PUPPET-SHOW.	DON QUIJOTE Y EL RETABLO.
Don Quixote, seeing such a swarm of Moors and hearing such a clamour, thought it would be well to aid	Viendo y oyendo pues tanta morisma y tanto estruendo D. Quijote, parecióle ser bien dar ayuda á los

the fugitives, and starting up, he cried aloud, " It shall never be said while I live that I suffered villainy to be done in my presence to so famous a knight and so bold a lover as Don Gayferos. Forbear your pursuit and persecution, you base-born curs or you will have me to deal with ! " So saying he drew his sword and with one spring got to the show and began to rain his blows upon the Moorish puppets with headlong fury, overthrowing some, beheading others maiming this, and demolishing that. Among others he delivered such an up and down stroke that if Master Peter had not ducked and crouched down, he would have sliced a piece off his head as easily as if it had been made of marchpane. Then Master Peter cried out, " Hold, hold, your worship ! Think what you are about, Don Quixote. These are not real Moors that you overthrow and hack and kill, but pasteboard puppets. Sinner that I am ! you are spoiling and destroying all my worldly goods." But Don Quixote did not cease cutting and slashing till in less than two credos he brought the whole show to the ground, with all the strings cut to pieces, and all the puppets smashed to atoms, King Marsilius wounded, and the Emperor Charlemagne's head and crown cleft in two. The audience fled in confusion ; the monkey escaped over the tiles of the inn ; the cousin was frightened, the page terrified, and even Sancho Panza

que huian, y levantándose en pié, en voz alta dijo : no consentiré yo que en mis dias y en mi presencia se le haga supercheria á tan famoso caballero y á tan atrevido enamorado como D. Gaiféros : deteneos mal nacida canalla, no le sigais ni persigáis ; si no, commigo sois en la batalla ; y diciendo y haciendo desenvainó la espada, y de un brinco se puso junto al retablo, y con acelarada y nunca vista furia comenzó á llover cuchilladas sobre la titerera morisma, derribando á unos, descabezando á otros, estropeando á este, destrozando á aquel, y entre otros muchos tiró un altibajo tal que si maese Pedro no se abaja, se encoge y agazapa, le cercenera la cabeza con mas facilidad que si fuera hecha de masa de mazapan. Daba voces maese Pedro diciendo : deténgase vuesa merced, señor D. Quijote, y advierta que estos que derriba, destroza y mata no son verdaderos moros, sino unas figurillas de pasta : mire ; pecador de mi ! que me destruye y echa á perder toda mi hacienda. Mas no por esto dejaba de menudear D. Quijote cuchilladas, mandobles, tagos y reveses como llovidos. Finalmente en menos de dos credos dió con todo el retablo en el suelo, hechos pedazos y desmenuzadas todas sus jarcias y figuras ; el rey Marsilio mal herido y el emperador Carlo Magno partida la corona y la cabeza en dos partes. Alborotóse el senado de los oyentes, huyóse el mono por los tejados de la venta temió el primo, acobardóse el

struck with fear and wonder, for, as he swore when the hurricane was over, he had never seen his master in such a blind rage before. The general rout of the puppets being over, Don Quixote calmed down a little and said, " I wish I had here before me all those who do not and will not believe in the good done by knights-errant in the world ; for see, if I had not been there, what would have become of good Don Gayferos and fair Melisandra ? These ruffians would have caught them long ago and used them ill. Therefore long live knight-errantry above everything on earth ! " " Long let it live," quoth Master Peter at that moment in a doleful voice, " and let me die, for I am so unfortunate that I can say with King Roderick, ' But yesterday I was lord of Spain and now I have not a turret to call my own.' "

page y hasta el mismo Sancho Panza tuvo pavor grandisimo ; como el juró despues de pasada la borrasca jamas habia visto á su señor con tan desatinada cólera. Hecho pues el general destrozo del retablo, sosegóse un poco D. Quijote, y dijo : quisiera yo tener aquí delante en este punto todos aquellos que no creen ni quieren creer de cuánto provecho sean en el mundo los caballeros andantes : miren si no me hallára yo aquí presente, que fuera del buen D. Gaiféros y de la hermosa Melisandra ; á buen seguro que esta fuera ya la hora que los hubieran alcanzado estos canes y les hubieran hecho algun desaguisado. En resolucion viva la andante caballeria sobre cuantas cosas hoy viven en la tierra. Viva en hora buena, dijo á esta sazon con voz enfermiza maese Pedro, y muera yo, pues soy tan desdichado que puedo decir con el rey D. Rodrigo : Ayer fui señor de España y hoy no tengo una almena que pueda decir que es mia.

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Miguel de Cervantes, (1547 to 1616), the greatest genius of Spain, had written many poems, plays, and tales in prose, and was fifty-seven before he produced " Don Quixote," the masterpiece which made his name immortal.

———

Miguel de Cervantes (1547–1616), el mas grande genio de España, escribió muchos poemas, comedias, é historias en prosa, tenia cincuenta y siete años cuando publicó Don Quijote, la obra maestra que hizo su nombre inmortal.

Key to Exercise III.

1. *El* cometa luce de noche.
2. Los niños vuelan *las* cometas.
3. *El* cólera es peligroso.
4. *La* cólera es un pecado.
5. El *corte* de este traje es bueno.
6. *La* corte de St. James.
7. *El* moral tiene mucha fruta.
8. *La* moral de las naciones difièren.

9. *El* pendiente es de brillantes.
10. *La* pendiente de esta cuesta es grande.
11. Se saluda con la cabeza.
12. Los ojos son para ver, y la nariz para *oler*.
13. La boca es para comer, y los dientes para masticar.
14. Las manos son para tocar las uñas para arañar.
15. Los piés son para andar.
16. Ir de paseo.
17. El perro se pelea con el gato.
18. Las sillas del comedor son verdes.
19. El carnicero trajo la carne, y el panadero el pan.
20. La cocinera guisa bien.
21. El portero abre la puerta de la casa.
22. El juez juzga el pleito y el abogado lo defiende.
23. El magistrado administra la justicia.
24. Pleitear es costoso.
25. Se puede apelar cuando se pierde un pleito.

Continued

ITALIAN

Continued from page 2348

By Francesco de Feo

VERB *Avere* (*concluded*).

IMPERATIVE MOOD.

Singular.

abbi (*àhbbe*), have (thou)
àbbia, have, let him or her have.

Plural.

abbiamo, let us have
abbiate, have (you)
àbbiano, have, let them have

SUBJUNCTIVE MOOD.

Present.

(*che*) *io àbbia*, that I (may) have
(*che*) *tu àbbia*, that thou have
(*che*) *egli àbbia*, that he have
(*che*) *noi abbiamo*, that we (may) have
(*che*) *voi abbiate*, that you have
(*che*) *essi àbbiano*, that they have

Perfect

(*che*) *io àbbia avuto*, (that) I may have had
(*che*) *tu àbbia avuto*, (that) thou have had
(*che*) *egli àbbia avuto*, (that) he have had
(*che*) *noi abbiamo avuto*, (that) we have had
(*che*) *voi abbiate avuto*, (that) you have had
(*che*) *essi àbbiano avuto*, (that) they have had

Imperfect.

(*che*) *io avessi*, (that) I had
(*che*) *tu avessi*, (that) thou had
(*che*) *egli avesse*, (that) he had
(*che*) *noi avèssimo*, (that) we had
(*che*) *voi aveste*, (that) you had
(*che*) *essi avèssero*, (that) they had

Pluperfect.

(*che*) *io avessi avuto*, (that) I had had
(*che*) *tu avessi avuto*, (that) thou had had
(*che*) *egli avesse avuto*, (that) he had had
(*che*) *noi avèssimo avuto*, (that) we had had
(*che*) *voi aveste avuto*, (that) you had had
(*che*) *essi avèssero avuto*, (that) they had had

CONDITIONAL MOOD.

Present.

io avrei, I should have
tu avresti, thou wouldst have
egli avrebbe, he would have
noi avremmo, we should have
voi avreste, you would have
essi avrèbbero, they would have

Perfect.

io avrei avuto, I should have had
tu avresti avuto, thou wouldst have had
egli avrebbe avuto, he would have had
noi avremmo avuto, we should have had
voi avreste avuto, you would have had
essi avrèbbero avuto, they would have had

INFINITIVE MOOD.

Present—*avere*, to have
Perfect—*aver avuto*, to have had

GERUND.

Present—*avendo*, having
Perfect—*avendo avuto*, having had

PARTICIPLE.

avuto (mas.), *avuta* (fem.), *avuti* (mas. pl.), *avute* (fem. pl.) = had

VERB *Èssere* (*concluded*).

IMPERATIVE MOOD.

Singular.

Sii (*scè-ee*) *sia*, be (thou)
sia, be (you), let him or her be

Plural.

siamo, let us be
siate, be (you)
sìano, be (you), let them be

SUBJUNCTIVE MOOD.

Present.

(*che*) *io sia*, (that) I (may) be
(*che*) *tu sia*, (that) thou (may) be
(*che*) *egli sia*, (that) he (may) be
(*che*) *noi siamo*, (that) we be
(*che*) *voi siate*, (that) you be
(*che*) *essi sìano*, (that) they be

Perfect.

(*che*) *io sia stato, -a*, (that) I have been
(*che*) *tu sia stato, -a*, (that) thou have been
(*che*) *egli sia stato*, (that) he have been
(*che*) *noi siamo stati, -e*, (that) we have been
(*che*) *voi siate stati, -e*, (that) you have been
(*che*) *essi sìano stati*, (that) they have been

Imperfect.

(*che*) *io fossi*, (that) I were
(*che*) *tu fossi*, (that) thou wert (were)
(*che*) *egli fosse*, (that) he were
(*che noi fòssimo*, that) we were
(*che*) *voi foste*, (that) you were
(*che*) *essi fòssero*, (that) they were

Pluperfect.

(*che*) *io fossi stato, -a,* (that) I had been
(*che*) *tu fossi stato, -a,* (that) thou had been
(*che*) *egli fosse stato,* (that) he had been
(*che*) *noi fossimo stati, -e,* (that) we had been
(*che*) *voi foste stati, -e,* (that) you had been
(*che*) *essi fòssero stati,* (that) they had been

CONDITIONAL MOOD.

Present.

io sarei, I should be
tu saresti, thou wouldst be
egli sarebbe, he would be
noi saremmo, we should be
voi sareste, you would be
essi sarèbbero, they would be

Perfect.

io sarei stato, -a, I should have been
tu saresti stato, -a, thou wouldst have been
egli sarebbe stato, he would have been
noi saremmo stati, -e, we should have been
voi sareste stati, -e, you would have been
essi sarèbbero stati, they would have been

INFINITIVE MOOD.

Present—èssere, to be
Perfect—èssere stato, to have been

GERUND.

Present—essendo, being
Perfect—essendo stato, having been

PARTICIPLE.

stato (mas.), *stata* (fem.), *stati* (mas. pl.), *state* (fem. pl.) = been

EXERCISE XI.

ON THE VERBS *Èssere* AND *Avere* (*continued*).

1. Se io avessi. 2. Se non avessi ? 3. Che egli abbia. 4. Che egli sia. 5, Che voi siate. 6. Se noi non fossimo ? 7. Se io non fossi. 8. Essi sarèbbero. 9. Essi avrèbbero avuto. 10. Se avessi avuto tempo, sarei venuto. 11. Se fossi . . . avrei . . . 12. Egli sarebbe . . . se essi non fòssero stati . . . 13. Avendo tempo . . . sarò . . . 14. Essi son poveri, ma sarèbbero ricchi se avèssero avuto . . . 15. Aver. 16. Di aver. 17. Abbiate pazienza. 18. Siate buoni.

NOTE. (i.) The infinitives *èssere* and *avere,* and their third persons plural *sono, erano, furono, avevano,* etc., are often contracted into *esser, aver, son, eran, furon,* etc. *Son* stands also for *sono,* first person singular.

NOTE. (ii.) *Se,* if, must never be used with the conditional ; say, *Se io avessi,* and not : *se io avrei* ; *se noi fossimo,* and not *se noi saremmo.*

OBSERVATIONS ON THE PLURAL OF NOUNS.

1. All nouns ending in *ca* and *ga* form their plural in *che* and *ghe,* if feminine, and in *chi* and *ghi* if masculine—*e.g., la barca* (*bàhrcah*), the boat, *le barche* ; *la paga* (*pàhgah*), the pay, *le paghe* ; *il monarca* (*monàhr-cah*), the monarch, *i monarchi* ; *il collega* (*collèhgah*), the colleague, *i colleghi.*

2. Feminine nouns in *cìa* and *gìa* end in the plural in *ce* and *ge,* if the *i* is not accented—*e.g., piòggia* (*pee-ò-dgee-ah*), rain, *piogge* ; *bilància* (*beelàhn-chee-ah*), scales, *bilance.* But if the tonic accent falls on the *i* of *cìa* and *gìa,* the nouns follow the general rule and change the *a* into *e* in the plural—*e.g., bugìa* (*boo-dgeè-ah*) lie, *bugìe* ; *farmacìa* (*fahr-mah-cheè-ah*), pharmacy, *farmacìe.*

NOTE. Whenever the omission of the *i* might cause ambiguity the plural of such nouns may end in *cie* and *gie—e.g., camìcia* (shirt), *audàcia* (audacity), and similar words, make in the plural *camìcie, audàcie,* in order not to be confounded with *càmice* (vestment), *audàce,* audacious (adj.).

3. Nouns in *co* and *go* form their plural, some in *ci* and *gi,* and some in *chi* and *ghi.*

(*a*) Nouns of two syllables end in the plural in *chi* and *ghi,* as : *cuoco* (*koo-òco*), cook, *cuochi* ; *fuoco* (*foo-òco*), fire, *fuochi* ; *ago* (needle), *aghi* ; *borgo* (borough), *borghi* ; *luogo* (place), *luoghi,* etc. Exceptions : *il porco* (the pig), *i porci ; Greco* (Greek), *Greci.*

(*b*) Nouns of more than two syllables in *co* end in the plural in *ci,* as : *amico, amici ; nemico, nemici ; medico, medici ; Austrìaco, Austrìaci.*

Exceptions : *antico* (*ahnteèco*), ancient, *antichi ; mànico* (*màh-neeco*), handle, *manichi* ; *vàlico* (*vah-leeco*), passage, *valichi ; rammàrico* (regret) *rammàrichi ; càrico* (loaded), *càrichi ; caduco* (frail, failing), *caduchi ; pudico* (*poodeè-co*), chaste, *pudichi ; opaco* (opaque), *opachi ; ubbriaco* (*oobree-àhco*), drunken, *ubbriachi ; dimèntico* (forgetful), *dimèntichi.* All nouns having a consonant before the syllable *co* end in the plural in *chi,* as : *Tedesco* (German), *Tedeschi ; Polacco, Polacchi.*

(*c*) Nouns of more than two syllables in *go* end in the plural in *ghi,* as : *albergo* (inn, hotel), *alberghi ; catàlogo* (catalogue), *catàloghi.* Exceptions : *teologo, teologi ; geologo, geologi,* and a very few more, all of Greek origin.

4. Nouns ending in *io* simply drop the *o* in the plural. if the *i* is not accented, as : *bàcio* (*bàh-chee-o*), kiss, *baci ; giudìzio* (*dgee-oodeè-tzee-o*), judgment, *giudizi.*

But they have two *i's* in the plural, when they might be confounded with other nouns similarly spelt and of different meaning—*e.g., princìpio* (*preen-cheè-peeo*), principle, *augùrio* (*ahoogoòreeo*), good wish, make in the plural *princìpii, augùrii,* in order not to be confounded with *prìncipi* (princes), *àuguri* (diviners). But, as we have already seen, such nouns are also distinguished by the grave accent : *princìpi, augùri.*

If the tonic accent falls on the *i* of words ending in *io,* they follow the general rule, and change the *o* into *i* in the plural, thus ending in *ii,* as : *ziò, zii, addìo* (good-bye), *addii.*

NOTE. The *h* inserted between the *c* and *g* and the terminations of the plurals of the nouns ending in *ca* and *ga,* and some of those ending in *co* and *go,* is not an irregularity. It is simply an orthographic sign employed to indicate that the letters *c* and *g* preserve the *hard sound* of

the singular, otherwise these letters would be pronounced *cheh, dgeh, chee, dgee*. The *i* of the nouns in *cia* and *gia* is also an orthographic sign, used to give the *c* and *g* a *soft sound* before *a*. In the plural the *i* is dropped, because it is no longer necessary, the sound of *c* and *g* being *soft* before the *e*.

Esercizio di Lettura

(Manzoni, *I Promessi Sposi*, Cap. XI.).

Una delle più gran consolazioni (1) di questa vita (2) è l'amicizia (3); e una delle consolazioni dell' amicizia è quell' avere a cui (4) confidare (5) un segreto. Ora (6), gli amici non sono due a due (7), come (8) gli sposi; ognuno (9), generalmente parlando (10) ne ha più d'uno (11): il che (12) forma una catena (13), di cui nessuno potrebbe trovar la fine (14). Quando dunque un amico si procura (15) quella consolazione di deporre (16) un segreto nel seno d'un altro, dà a costui la voglia di procurarsi (17) la stessa consolazione anche lui. Lo (18) prega, è vero (19), di non dir nulla a nessuno (20); e una tal (21) condizione, chi la prendesse nel senso rigoroso delle parole (22), troncherebbe (23) immediatamente il corso delle consolazioni. (*Continued.*)

Notes. (Expressions have been chosen which shall correspond as nearly as possible with the exact meaning of the Italian words). 1. Of the greatest consolations. 2. Life. 3. Friendship. 4. To whom. 5. Entrust. 6. Now. 7. In pairs. 8. As. 9. Everyone. 10. Generally speaking. 11. Has more than one of them (*ne*). 12. Which (referred to the preceding sentence). 13. Chain. 14. Of which no one can find the end. 15. Procures himself. 16. Of depositing. 17. Gives him an inclination to procure himself. 18. Him. 19. It is true. 20. Not to tell anything to anyone. 21. Such. 22. Were any one to take it in the rigorous sense of the words. 23. Would cut short.

Conversazione.

Buon giorno (good morning), signore; siete già di ritorno (back) a Londra?

Sì, perchè mia sorella è stata ammalata (ill); ma sarò a Parigi fra due o tre giorni.

Vi sono molti Inglesi nel vostro albergo?

No, ma vi sono molti Tedeschi. Vi sono anche i due mèdici italiani e le due signorine polacche, che abbiamo conosciute a teatro l'inverno scorso (last winter).

Sono comodi gli alberghi in Francia?

Le càmere (bed-room) sono ordinariamente molto larghe e il servizio è eccellente.

Che cosa (what) avete comprato?

Abbiamo comprato due paia di guanti (gloves), un cappello e delle camìcie. Le nostre amiche non hanno comprato niente (nothing), perchè non avèvano danaro.

Che cosa avrèbbero comprato se avèssero avuto danaro?

Esse avèvano intenzione di comprare (to buy) un anello.

Se avete sete, li c'è (there is) dell' acqua (water) e una bottiglia di vino.

Gràzie.

Key to Exercise IX.

In our garden we have fruit[s] and flowers. The boys have gathered some flowers for the visitors, and they have had [got] some money. The dresses of the ladies are in the wardrobe. Your hands are dirty. The workmen will have their wages (the pay) every week. The lamps are on the table. In the schools, in the churches, in the theatres, they have collected money for those damaged by the earthquake. The inhabitants are without shelter. The soldiers had orders to go to the damaged cities. There are many victims. The pupils will have paper, pencils, and pens. The officers have given (gave) a dinner in honour of the English fleet; there have been (were) many toasts. They have opened a school for the deaf and dumb. We have many bottles of wine, but we have no corkscrew. We have not written the letters, because we have not found the addresses. When you [will] have written the answers you will be at liberty to go.

Key to Exercise X.

1. The hand has five fingers. 2. The laughter of the boys. 3. A waggon drawn by two pairs of oxen. 4. The two right wings of the enemy's army were of ten thousand men each. 5. We shall be cold this evening, because we have no firewood in the house. 6. We have bought some eggs and some bread because we are hungry. 7. I am very cold; I am chilled to the bone (literally, I have chills in my bones). 8. Where are the scissors? There they are, on the table, together with the spectacles. 9. The peasants have brought fruit[s] and flowers for the silver wedding of their masters. 10. On the death of her aunt that girl will have several thousands a year.

Continued

FRENCH

Continued from page 2349

By Louis A. Barbé, B.A.

IMPERFECT INDICATIVE TENSE

The endings of the imperfect of the indicative are the same in all verbs. They are *-ais, -ais, -ait, -ions, -iez, -aient*. This tense is used to express customary or repeated action, and, in narratives, to describe accompanying circumstances, state, or condition:

Autrefois je le rencontrais tous les jours, Formerly I used [to] meet him every day.

Il ventait, il pleuvait, le temps était très rude, The wind [was] blowing, it [was] raining, the weather was very rough.

Un bon feu flambait dans la cheminée, A good fire was blazing in the hearth.

Imperfect Indicative of Avoir: I had, used to have:		*Imperfect Indicative of Être:* I was, used to be:	
j'avais,	*nous avions*	*j'étais*	*nous étions*
tu avais	*vous aviez*	*tu étais*	*vous étiez*
il avait	*ils avaient*	*il était*	*ils étaient*
elle avait	*elles avaient*	*elle était*	*elles étaient*

Imperfect Indicative of Donner:
I used to give, was giving:

je donnais	*il donnait*	*nous donnions*
tu donnais	*elle donnait*	*vous donniez*
ils donnaient	*elles donnaient*	

In expressions of time *il y a* is equivalent to the English "ago." It always precedes the words that indicate the length of time:

Il y a dix minutes, Ten minutes ago.
Il y a trois ans, Three years ago.

Exercise XIX.

Vocabulary

aile (f.), wing
le bec, beak
le biscuit, biscuit
le bouvreuil, bullfinch
le bruit, noise
la cage, cage
la chambre à coucher, bed-room
le chènevis, hemp-seed
les cheveux (m.), hair
le compagnon, companion
la connaissance, acquaintance
le cou, neck
la croisée, window
le danger, danger
le déjeuner, breakfast
le dos, back
épaule (f.), shoulder
expression (f.), expression
la fin, end
le fumier, heap of manure
le gazouillement, chirp
la gorge, throat
le goût, taste
la griffe, claw
l'histoire, (f.), story
l'humeur (f.), temper
intrus (m.), intruder
la journée, day (day-long)
le lendemain, next day
la main, hand
la miette, crumb
le moineau, sparrow
le mois, month
oiseau (m.), bird
le pain, bread
le pas, footstep, pace
le plumage, plumage
la poitrine, breast
la poule, hen
la prison, prison
la provision, stock
le rebord, edge, sill
le rouge-gorge, robin
le secours, help
le séjour, stay
la soirée, evening
le son, sound, note
le sucre, sugar
la tête, head
la voix, voice
la vue, sight

aimable, kind, kindly
ample, ample
brun, brown
content, pleased
doux, sweet, gentle
dur, hard
entre-baillé, slightly open
épais, thick
gai, cheery
gentil, nice, amiable
hargneux, snappish, surly
heureux, happy
intolérant, intolerant
jaune, yellow
lustré, glossy
moelleux, soft
noir, black
rouge, red
rude, rough
tacheté, spotted, speckled
triste, sad
varié, varied

amuser, to amuse
apporter, to bring
attaquer, to attack
attirer, to attract
becqueter, to peck
caresser, to pet, caress
charmer, to delight
chasser, to drive off
demander, to ask for
donner, to give
ébouriffer, to rumple, disorder
égayer, to enliven, cheer
enjamber, to step over
entourer, to surround
éveiller, to waken
fâcher, to anger
filer, to warble, trill
flamber, to blaze
gratter, to scratch, scrape
houspiller, to worry, to mob
inquiéter, to trouble
passer, to spend, pass
rentrer, to come in, return
saluer, to salute
sauter, to jump
soigner, to tend
tirer, to draw away, rescue
tourner, to turn
trouver, to find
vagabonder, to roam about
voler, to fly
voleter, to flutter

endormi, asleep
entendu, heard
fait, made
mort, dead
ouvert, open
vu, seen

à travers, through
autour de, about, around
bien (before adjectives), very
dehors, outside
ne . . . jamais, never
même, even
pendant que, whilst
presque, almost, nearly
quelquefois, sometimes
souvent, often
trop tard, too late
vite, quickly

Translate into French.

You ask me for the story of my bullfinch; here it is. A friend of mine has a house in the country. I sometimes spend the winter at his house. *I* like the country in winter; *you* like the town better. Each one (to) his taste. Two years ago I (have) made a stay of several months there, and whilst I was there I made the acquaintance of a bullfinch. He was a little bigger than a sparrow; his beak was thick, black, and hard; his little eyes had a kindly expression. I have never seen any plumage more beautiful, more glossy than his. His head was black and his breast almost as red as a robin's. His wings were spotted with (*de*) red also. His voice was sweet, and I have never heard any notes softer and more varied than those which he warbled. He cheered me and delighted me. I tended him, I petted him. When my breakfast was brought me, I gave him his also. I gave him all that he liked most; crumbs of bread, little pieces of biscuit and of sugar. He pecked them in my hand. We were very good friends, he and I. The winter was rough, but that did not trouble us. A good fire blazed in the hearth. We had an ample stock, I, of books, he, of hemp-seed. We were both happy; we were pleased with (*de*) each other. For birds, a cage is often only a prison. *His* was only a bedroom. The door of it was always open. Almost all day long he roamed about through the room. It did not belong more to me than to him. Sometimes he fluttered round me; he jumped on my shoulder, and even on my head; he rumpled my hair. That amused him, and me too. He was a cheery companion. I have never had any nicer than that one. I did not spend all my evenings with him. When I returned I used to find him asleep. He had his head under his wing. The noise of my footsteps used to wake him. He used to salute me with (*par*) a little chirp. Next day I was awakened by my little friend. But the end of my story is something very sad. One day the bullfinch finds the window slightly opened. Whilst I have my back turned, he passes quickly outside. Twenty paces from the house, there is

a large heap of manure, yellow and black, where half a dozen hens scratch and peck. It is nothing fine, but it is something interesting for him. From the ledge of the window he flies on to the manure heap. But he is an intruder. The hens have an (the) intolerant and surly temper. The sight of the bullfinch angers them. They surround him, worry him, attack him. The noise attracts me. I look through the window. It is he; it is my poor bullfinch. I step over the window; I go to the help of my little companion. I drive the hens away; I rescue him from their claws. It is too late. My poor little companion is dead.

Key to Exercise XVIII.

1. Où peut-on être mieux qu'au sein de sa famille ?
2. On nous a dit de vous donner ceci.
3. On obéit à ce roi parce qu'on le craint, mais personne ne l'aime.
4. On dit qu'il est très riche.
5. Quiconque a fait cela est un méchant homme.
6. Si quelqu'un vous parle, répondez-lui.
7. Je ne connais personne ici et personne ne me connaît.
8. Si vous avez encore de ces poires, donnez-m'en quelques-unes.
9. Quelqu'un (on) demande à vous parler.
10. Nous avons appris quelque chose de très intéressant.
11. Je connais quelqu'un de plus puissant que lui.
12. Nous n'avons pas fait grand'chose de bon aujourd'hui.
13. Il n'y a rien de plus agréable que de voyager à pied.
14. Y a-t-il rien de plus surprenant que cette histoire ?
15. Chacun de mes amis a remporté plusieurs prix.
16. Faites à autrui ce que vous voudriez que l'on vous fît.
17. J'ai parlé à l'un et à l'autre.
18. Les vrais chrétiens ne médisent pas les uns des autres.

Continued

GERMAN

Continued from page 2352

By P. G. Konody and Dr. Osten

Plurals of Nouns

XXXVII. The Plural of Proper Nouns is formed in German as rarely as in English. Proper nouns shared by several persons, and those employed in a collective sense, remain sometimes unaltered in the plural—for instance: die beiden Frankfurt (*pl.*), the two towns of Frankfort; or add an -e, -en, -n, -r, -s: Ludwig (*s.*), Louis; and die beiden Ludwige (*pl.*) von Frankreich, the two Louis of France; but also die Ludwig (*pl.*) and die Ludwigs (*pl.*); die sieben Eduarde von England, the seven Edwards of England (also die Eduard and die Eduards); Maria or Marie (*s.*), Mary; and die Marien von Schottland, the Marys of Scotland, etc. Proper nouns of Latin and Greek derivation either remain unaltered, or form the plural like other substantives of foreign origin.

XXXVIII. The Double Plural. Several substantives with the same or double gender, and with the same or different meaning, form the plural in two different ways:

Singular	*Plural*	*Plural*
der Akt, document, act of a drama	die Akten, documents	die Akte, acts
der Band, volume, and das Band, ribbon	die Bände, volumes	die Bänder, ribbons
die Bank, bench, die Bank, bank	die Bänke, benches	die Banken, banks
der Bauer, peasant, das Bauer, birdcage	die Bauern, peasants	die Bauer, birdcages
der Bund, union, alliance das Bund, bunch	die Bünde, unions	die Bunde bunches
das Gesicht, face, vision	die Gesichte, visions	die Gesichter, faces
der Laden, shop, shutter	die Läden, shops	die Laden, shutters
der Schild, shield, das Schild, signboard	die Schilde, shields	die Schilder, signboards
der Strauß, bunch of flowers, ostrich	die Sträuße, bunches of flowers	die Strauße ostriches

1. Several other nouns form a double plural without, and some with, different meaning —*e.g.*: das Gastmal (*s.*) banquet, feast, die Gastmale (*pl.*) and die Gastmäler (*pl.*); das Band (*s.*) tie, ribbon, die Bande (*pl.*) [der Natur, des Blutes, des Gesetzes], the ties [of nature, of blood, of law], and die Bänder (*pl.*) ribbons; der Ort (*s.*) place, locality, die Orte (*pl.*) places, and die Örter, communities; das Wort (*s.*) word, die Worte (*pl.*) words, and die Wörter (*pl.*) words in the sense of vocables; das Land (*s.*) country, die Lande (*pl.*) [rhetorical form] and die Länder (*pl.*) countries.

Interrogative Pronouns

XXXIX. The Interrogative Pronouns are: (*a*) wer? who? (*b*) was? what? (*c*) welcher (*m.*), welche (*f.*), welches (*n.*)? which? and (*d*) was für ein (*m.* and *n.*), eine (*f.*)? what sort of? Wer and was are used substantively; the former applied to persons, the latter to objects. The declension of (*a*), (*b*), (*c*) is:

	(*a*)	(*b*)	(*c*)	*Plural for all 3 genders*
nom.	wer	was	welcher welche welches	welche
gen.	wessen (wes *)	wessen (wes)	welches (en) welcher welches (en)	welcher
dat.	wem	—	welchem welcher welchem	welchen
acc.	wen	was	welchen welche welches	welche

* Used in proverbs, etc.: Wes das Herz voll ist, geht der Mund über, Of what the heart is full, the mouth overflows.

Examples: (*a*) Wer fragt? Who is asking? (*b*) Was sagst du? What do you say?

1. Welcher, welche, welches is always either directly connected with, or used with reference to, a substantive; it has the character of an attributive adjective and is declined like one [see XXVI.] When used as an exclamation, it takes the shortened and indeclinable form welch, similar to the demonstrative pronoun solcher, solch, and mancher (many a), manch ein. In this case it is either followed by the substantive with or without an adjective, or by the indefinite article—for instance: welch schöner Tag, what [a] beautiful day; welch schöne Landschaft, what [a] beautiful landscape; or, with inserted indefinite article: welch ein schöner Tag, welch eine schöne Landschaft.

2. The indefinite article can *never* precede the interrogative pronoun welcher, whilst it may precede the demonstrative solcher: ein solcher Tag! such a day, but welch' ein Tag! what a day, and *never* „ein welcher Tag!"

3. Was für? What sort of? which? cannot be declined, and is used in direct connection with substantives denoting materials and abstract ideas —for instance: Was für Wein? What sort of wine? was für Glaube? which creed? In all other cases the indefinite article is inserted: was für ein Hut ist das? what sort of hat is that? The indefinite article is of course declinable. Without substantive was für ein? takes the lengthened form was für einer (*m.*)? was für eine (*f.*)? was für eines (*n.*)? and is used substantively. Ein having no plural, the plural of was für ein is expressed by was für welche?

4. If the interrogative pronoun was? (what?) is used with the prepositions an, auf, über, nach, zu, etc. [see XXV.], it is replaced by the adverb wo, contracted with the prepositions (woran? worauf? worüber? wonach? wozu? etc.), the latter being placed at the end. For the sake of euphony an r is inserted between two vowels. It is not usual to say: An was denken Sie? What are you thinking of? but: Woran denken Sie? nor: Zu was dient dieses Rad? What purpose does this wheel serve? but: Wozu dient dieses Rad?

Prepositions

XL. The following is a complete list of the German prepositions arranged according to the cases ruled by them:

PREPOSITIONS GOVERNING THE GENITIVE:

anstatt' (or statt), instead of	um . . . willen, for the sake of
au'ßerhalb, outside of, (without)	un'beschadet, without prejudice to
dies'seits, this side of	un'geachtet, despite, although
halber (or halben *), on behalf of	un'terhalb, beneath, below
jen'seits, that side of	un'weit (or unfern †), not far from
in'nerhalb, within	vermö'ge, in virtue of, by means of
kraft, by power of	vermit'telst (or mittels), by means of
längs †, along	o'berhalb, above
laut, according to	trotz ‡, in spite of
wäh'rend, whilst, during	wegen *, on account of
zufolge †, according to, in consequence of	

* Is *always preceded* by the substantive: des lieben Friedens halber, for the sake of [dear] peace.

† Also used with the dative.

PREPOSITIONS GOVERNING THE DATIVE:

aus, out of, from	nächst (zunächst'), next to
außer, except	nebst, with, together with
bei, near, about, with	ob §, on account of
binnen, within	sammt, together, with
entgegen, against	seit, since
gegenü'ber, opposite	von, from, of, by
gemäß', according to	zu, to
mit, with	zuwi'der, contrary to
nach, after	

PREPOSITIONS GOVERNING THE ACCUSATIVE:

bis, till	oh'ne, without
durch, through	um, for, about, around, on account of
entlang ¶, along	wider, against, contrary to
für, for	
gegen, against, towards	

For the prepositions governing alternately the dative and the accusative, and for the contractions of prepositions with the definite article, see XXV.

Classification of Verbs

XLI. The classification of verbs is most important, as it is the basis for the rules concerning the employment of the auxiliary verbs sein and haben.

As regards their dependence and influence on other nouns, the verbs can be classified as follows: (*a*) *intransitive*, (*b*) *transitive*, (*c*) *reflective* and *reciprocal* [see 5], and (*d*) *impersonal* verbs [see 6].

(*a*) Intransitive verbs want no completion to convey their full meaning—for instance: die Sonne scheint, the sun shines; der Wind bläst, the wind blows, etc.

(*b*) Transitive verbs require the aid of objects in the accusative to make their meaning fully obvious—for instance: das Kind liebt seine Eltern, the child loves its parents, etc. Transitive verbs can always be brought into the passive form if the *object* (accusative) is made the *subject* (nominative)—for instance: die Eltern werden von ihrem Kinde geliebt, the parents are loved by their child.

1. There are some verbs which require completion by a noun in the genitive or dative—*e.g.*: bedür'fen, to require, want; raten, to advise, etc.; ich bedarf deiner, I want [of] thee; and rate mir, advise me. These are not counted among the

* Can be alternately preceded or followed by the substantive: Wegen des lieben Friedens, or des lieben Friedens wegen, for the sake of [dear] peace.

† Also used with the dative, if *preceded* by the substantive—for instance: Einem Berichte zufolge (*dat.*), according to a report; but: Zufolge eines Berichtes (*gen.*).

‡ Also used with the dative.

§ In poetic speech also with the genitive: Ob dieser Kunde (*gen.*) herrschte Trauer rings im Land, On account of this news mourning reigned throughout the land.

¶ Sometimes used with the dative, and very rarely with the genitive.

transitive verbs, the characteristic of which is the power to govern a noun in the accusative, but among the intransitive verbs.

2. Other verbs are used with prepositions and are thus connected with complementary nouns in the cases required by the prepositions—*e g.:* wir lachten über ihn (*acc.*), we laughed at him; er strebte nach Reichtum (*dat.*), he strove for wealth, etc. Bear in mind the essential difference between the *prepositional-accusative* of the intransitive and the *object-accusative* of the transitive verbs.

3. The same difference occurs in the case of the accusative determining the *measure* and answering to the questions: how much? how far? how long? etc., which always determine the *intransitive* character of the verb—for instance: der Kauf'mann wog den Zucker, the merchant (grocer) weighed the sugar (transitive); but: der Zucker wog zehn Pfund, the sugar weighed ten pounds (intransitive with accusative of measure).

4. Intransitive verbs can also be brought into the passive form by the introduction of the impersonal es, it: die Sonne scheint, the sun is shining; and: es wird von der Sonne geschienen, which, though correct, is a clumsy form and should not be used.

5. Some verbs are only used in connection with certain personal pronouns, in the sense that the action is reflected upon the acting person. The complement (object) is here identical with the subject—for instance: Ich sehne mich nach etwas, I long for something; er schämt sich, he is ashamed, etc. These are called *reflective verbs.* If the acting persons are in the plural, a reciprocity of reflection may take place, in which case the verbs are called *reciprocal*: sie ärgerten einander, they annoyed one another (each other).

6. *Impersonal* verbs denote either natural phenomena ascribed to impersonal agency, and are therefore used with the impersonal es, it; (examples: es regnet, it is raining; es donnert, it is thundering, etc.); or the impersonal action of certain feelings or sensations on persons: es hungert mich, I am hungry [it hungers me], etc. Verbs are also used impersonally to denote occurrences due to some impersonal motive power; es giebt ein Wie'dersehen, in the sense of there is the possibility of seeing each other again.

7. Many verbs belong alternately to both groups—the transitive and the intransitive—according to their relation to the object of the sentence.

EXAMINATION PAPER XI.

1. Which are the plural inflections of proper nouns?
2. What rule determines the use of the interrogative pronouns wer? and was?
3. What are the relative positions of the indefinite article and the shortened form of welcher [welch']?
4. By which compounds is the interrogative pronoun was replaced if it is used with the prepositions auf, über, nach, zu; and what has to be kept in mind with regard to euphony?
5. Which preposition governs different cases according to its position before or after the substantive?
6. What is the chief guide in determining whether a verb is transitive or intransitive?
7. To which class belong those verbs that require, for the completion of their meaning, a noun in the genitive or dative?
8. What is the characteristic case of the substantive governed by a transitive verb?
9. What is the difference between the accusative of measure and the object-accusative with regard to the verb?
10. How can sentences with intransitive verbs be changed into the passive form?
11. Have the impersonal verbs a larger scope in German than in English; and to what feelings, sensations, or ideas is the supposed impersonal action extended?

EXERCISE 1 [see last lesson]. Change the present tense in the following sentences into the imperfect and pluperfect. (Mind the arrangement of the sentence with regard to the past participle and finite verb.)

Ich nehme das Geld; der Knabe stiehlt einen Apfel;
I take the money; the boy steals an apple;
was geschieht? ich lese ein Buch; ihr seht
what happens? I am reading a book; you see
nichts; geben Sie nichts?* du verbirgst
nothing; do you give nothing? thou hidest
etwas; wir werfen den Ball; die Dame spricht
something; we throw the ball; the lady speaks
englisch; ich esse Erd'beeren;
English; I eat strawberries;
er vergißt alles.
he forgets everything.

EXERCISE 2. Insert the correct plural terminations of the following words with double plural form:

Das Lustspiel hat vier Akt . . .; in seinen Träumen
The comedy has four acts; in his dreams
hatte er seltsame Gesicht . . .; die Ritter erhoben ihre
he had queer visions; the knights raised their
Schilde . . .; der Richter brachte die Akt. . . . Alle
shields; the judge brought the documents; all
hatten bleiche Gesicht. . .; die Schild . . . über den Laden-
had pale faces; the sign-boards above the shop-
türen waren gemalt; wie viele . . . . haben Sie?
doors were painted; how many volumes have you?
Die . . . . . . des Hutes sind rot; die . . . . der Vögel
The ribbons of the hat are red; the birdcages
waren aus Gold; die . . . . kennen das Wetter.
were of gold; the peasants know the weather.

EXERCISE 3. Insert in the blank spaces the missing interrogative pronouns:

. . . . . ist dieser Herr? . . . . meinen Sie?
Who is this gentleman? What do you mean?
. . . . . . Hut ist das? . . . . . . gehört dieses Buch?
Whose hat is this? To whom belongs this book?
. . . . sahen Sie gestern? . . . . Manne
Whom did you see yesterday? To which man

* Be careful about the arrangement of the words.

gehört das Boot? ..... Dame kennen Sie?
belongs the boat? Which lady do you know?
.... Kinder sollen eingeladen werden? ..... glänzender
Which children are to be invited? What [a] brilliant
Spieler er ist! ...... schöne Kind sahen Sie?
player he is! Which beautiful child did you see?
.... schönes Kind! .... Leute
What [a] beautiful child! What sort of people
sind sie? .... Getränke bestellten Sie?
are they? What drinks did you order?
.... Frau war es?
What sort of woman was it?

Exercise 4. Insert the missing words and terminations in the cases required by the prepositions:

Diesseits ... Mauer (*f.*), innerhalb ... Garten .. (*m.*),
On this side of the wall, within the garden,
stand ein Mann inmitten ..... Wiese (*f.*).
stood a man in the midst of the meadow.
Zufolge ein .. Bericht .. (*m.*) war der Feind geflohen,
and: Ein .. Bericht .. zufolge war der Feind geflohen.
According to a report, the enemy had fled.
Trotz mein .. Warnung .. (*f.*) sprach er mit ihm;
In spite of my warnings, he spoke with him;
um ... Himmel .. (*m.*) willen! Mein .. Haus .. gegenüber
for heaven's sake! Opposite to my house
wohnt ein Schneider seit ein .. Jahr .. (*m.*); ich öffnete
lives a tailor since a year; I opened
(a tailor has been living for a year)
mittelst .... Schlüssel .. (*m.*) die Türe. Seit
the door with (by means of) a key. Since
Ihr .. Abreise (*f.*) sah ich ihn nicht mehr;
your departure I did not see him any more;
wir spazierten durch ... Garten (*m.*) gegen ... Wald (*m.*);
we walked through the garden towards the forest;
er tat es wider mein .. Willen (*m.*).
he did it against my will.

Keys to Exercises in Examination Paper X. [page 2352].

Exercise 1. *Imperfect:* Ich band einen Kranz; der Vogel sang; das Reh sprang und trank; das Werk gelang; wir tranken Wein; das Wasser rann ins Thal; er schwamm ausgezeichnet; ich saß im Garten; das Schiff sank; die Glocke klang laut; der arme Mann bat, etc.; ich gewann das Spiel; er besaß ein Haus.

Perfect: Ich habe einen Kranz gebunden; der Vogel hat gesungen; das Reh ist gesprungen und hat getrunken; das Werk ist gelungen; wir haben Wein getrunken; das Wasser ist ins Tal geronnen; er ist ausgezeichnet geschwommen; ich bin im Garten gesessen; das Schiff ist gesunken; die Glocke hat laut geklungen; der arme Mann hat um eine Unterstützung gebeten; ich habe das Spiel gewonnen; er hat ein Haus besessen.

Exercise 2. Ein solcher Freund ist selten; solch ein Freund ist selten; er ist der Sohn dieses Mannes und jener Frau; wir sprachen mit diesem Knaben und mit jenen Männern; sie sprach viel von ihrer Tochter und von deren Erfahrungen; der Himmel ist jenen gnädig, die ihn anrufen; der Jäger marschierte hinter seinem Herrn und trug dessen Gewehr; ich vertraue demjenigen, welcher mir vertraut; ist dies Ihre Frau? Nein, dieses ist meine Cousine; dies sind ihre Schwestern und deren Gatten; sie antwortete, sie würde denjenigen Mann heiraten, der ihr am besten gefiele.

Exercise 3. (*a*) Es ist eine Freude, einen solchen Sohn zu haben. Ein solches Unglück! Eines solchen Mannes Sohn sollte von anderer Art sein. Wie konnten Sie einer solchen Frau eine solche Unhöflichkeit sagen? Ein solcher Tag ist schrecklich. Einem solchen Künstler muß man einen solchen Irrtum verzeihen. Einem solchen Manne, einer solchen Frau, einem solchen Kinde bin ich noch niemals vorher begegnet.

(*b*) Solch ein Skandal wegen solch einer Kleinigkeit! Solch eines Mannes Pflicht ist Großmut; solch einem Unglück gegenüber ist der Mensch wehrlos; solch einen Fall habe ich in solch einer Familie noch nicht erlebt!

Continued

VARIETIES OF BIRDS

278. Gull flying 279. Herring Gull 280. Eagle Owl 281. Yellow-crowned Penguin 282. Blue-fronted Amazon Parrot 283. Black Cormorant 284. Pigeons 285. Buzzard 286. Nut-hatch

[*Photographs by Prof. Bentley & Messrs. Dando, McClellan, Newman, Reid*]

FEEDING & MOVEMENT OF BIRDS

Carnivorous and Vegetarian Birds. Hoppers, Walkers, Runners, and Climbers. Organs of Flight. Swimming and Diving Birds

continued from page 2214

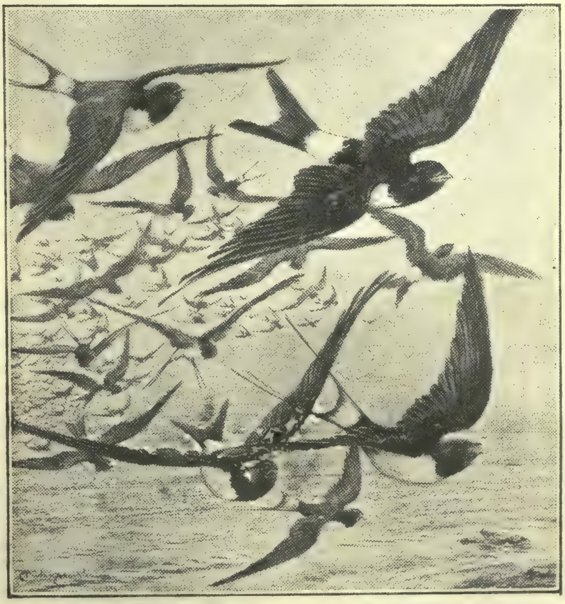
By Professor J. R. AINSWORTH DAVIS

FOOD OF BIRDS

Birds of Prey. Eagles, falcons, hawks, harriers, buzzards [285], and the like are adapted for the pursuit of prey not only by possession of strong hooked beaks, powerful talons, and keen powers of vision, but also by the swiftness of their flight. Many of them—for example, falcons—are able to poise themselves, apparently motionless, in the air till some such prey as a young rabbit or small bird is discovered, and then swoop down upon the victim with almost incredible rapidity.

Carrion Eaters. The carrion feeding vultures are able to detect dead animals from very considerable distances by means of their keen sight, and are extremely gluttonous. The little Egyptian vulture (*Neophron percnopterus*) of North Africa, India, and part of Europe, is said to devote its attention to the bones of carcases which have been picked clean by other carrion eaters. In Spain it is known as the "quebranta-huesos" (bone smasher), because it breaks bones by carrying them to a height in the air and letting them fall on rocks.

A similar habit is attributed to the bearded vulture, or lammergeier (*Gypaetus barbatus*), and possibly tortoises may be cracked in the same rough-and-ready manner. Pliny asserts that the Greek poet Æschylus was accidentally killed by some such bird, which mistook his bald head for a convenient boulder on which to drop its prey.



287. MARTINS CHASING INSECTS

The Snake's Foe. The curious African secretary bird (*Serpentarius secretarius*) is a long-legged form which pursues all sorts of small animals on the ground, and is particularly partial to snakes. The reptile is assailed with simultaneous blows from legs and wings, the latter also serving as a shield. In South Africa the bird is often tamed, rendering valuable service by the war it wages upon poisonous serpents.

Owls [280] avoid competition with the ordinary birds of prey by feeding at dusk and dark, such small creatures as rats and mice bulking largely in their diet.

Insect-eaters. The tribe of insects supplies many birds with food. Swifts, swallows and martins [287] hawk for them on the wing during the day, and the night-jars in the gloaming. Tits, creepers, nut-hatches [286], and the like pursue them on trees, where also they are exposed to attacks from the powerful beaks of woodpeckers. Caterpillars are eagerly sought out by many small birds, and those which are too well protected by bristles to suit ordinary digestions are acceptable to the cuckoo. The grubs and pupæ of insects which live in the soil are probed for by many strong-billed birds, and insects in all stages inhabiting fresh water are by no means free from the ravages of wagtails and many other feathered enemies.

Fish Feeders. Fishes, again, are a very favourite kind of food with numerous birds. Sea-eagles and ospreys live mostly upon them, and the same is true of large numbers of aquatic forms. In average cases the beak of a fish-eater is elongated and tapering, often with a bent or hooked tip, as seen in the black cormorant [283], which fishes along the coast. Gulls and their allies go further from the land, and the albatross affects the open ocean. Nor are fresh-water fishes free from foes. Long-legged waders, such as herons, angle for them in the shallows, and kingfishers pounce down upon them from branches overhanging streams.

Some birds—for example, the divers—are able to pursue their finny prey a greater or less distance under water, and this habit is carried to an extreme in the penguins, the wings of which have been converted into efficient paddles [281].

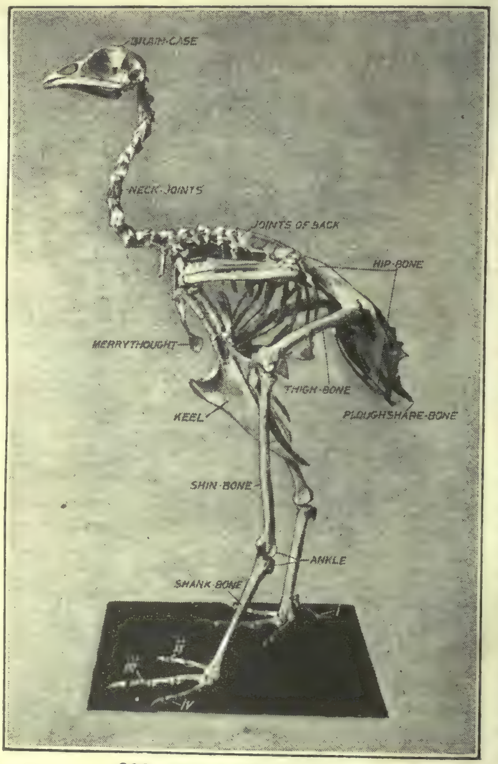
Worm-eaters. Worms of all sorts figure in the dietary of a host of birds, some of which possess long beaks adapted to probe for them in the earth, as well seen in the woodcock. The same is true of the kiwi of New Zealand, and here the nostrils are at the end of the long beak, instead of at its base, this being apparently an arrangement for smelling out the wriggling prey [**277**, page 2213].

Shell-fish of various kinds are also used as food by a number of birds. Gulls ravage cockle-beds, and the oyster-catcher, or sea-pie (*Hæmatopus ostralegus*), hunts for molluscs (and crustaceans) on the shore. The snails and slugs of the land and the snails of fresh water receive many attentions at the beaks of their enemies, and the thrush has learnt the art of cracking the hard shells of snails on some suitable stone, to which it returns again and again with fresh victims.

The broad bills of ducks and swans, which are adapted for feeding upon small worms, snails, etc., contained in mud, have extremely sensitive edges, and also a number of transverse ridges that serve as a sort of strainer. In geese these ridges are of use for cutting through herbage, while the mergansers find them helpful in securing fish.

In birds which affect a mixed diet, or feed on soft vegetable food, the beak is commonly a moderately long cone. Seed eating birds, such as finches, possess short strong conical beaks.

Vegetarian forms with beaks of peculiar shapes or character, such as crossbills, parrots, and toucans have been spoken of elsewhere.



288. SKELETON OF FOWL

Digestive Organs. As an example of the internal digestive arrangements in birds which swallow a good deal of hard food, we may conveniently take the domestic pigeon [**284**]. Here the gullet is swollen into a large crop, the inflation of which gives such a peculiar appearance to a pouter. It is used for temporary storage and passes into a somewhat oval chemical stomach, from the lining of which the gastric juice is poured out. Then follows a rounded gizzard or mechanical stomach, with extremely thick muscular walls and a tough lining. This organ makes up for the absence of teeth, for it rhythmically contracts and dilates, thus bringing pressure to bear upon the food contained within it. Small stones and other hard objects are constantly being swallowed, which pass into the gizzard, there to play the part of millstones.

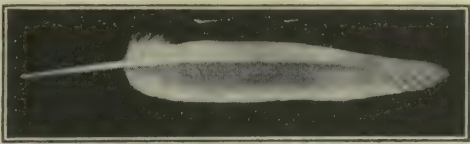
MOVEMENT OF BIRDS

Hopping, Walking, and Running Birds. Adaptation to flight has profoundly affected the structure of birds in a large number of ways, some of which may be gathered from the appended illustrations of the skeleton of a fowl [**288**] and of an osprey [**290**], the latter disarticulated and displayed. Of course, most of these peculiarities are still possessed by birds, such as ostriches, which have lost the power of flight. The somewhat boatshaped body is supported by a strong, bony framework, which allows of but little movement from side to side, largely because the joints of the backbone are here, for the most part, closely fused together. The inconvenience of this arrangement is compensated for by the fact that the neck is long and very flexible, as must have been observed by anyone who has taken the trouble to watch a living bird. Some of the joints of the short tail are free, but those at the end have fused into a ploughshare bone for the support of the quill feathers of that region.

The Limbs. The breastbone (sternum) possesses a large projecting keel to which the muscles of flight are attached. The shoulder-girdle, to which the wing is jointed on, consists of three bones, one of which is the collar-bone (clavicle), united with its fellow to make up the familiar merrythought, which serves as a spring to keep the wings well apart. In the wing itself there are but three digits, the fourth and fifth fingers having disappeared.

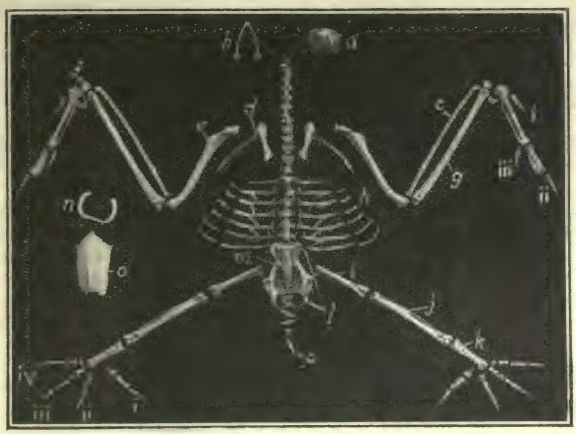
Owing to the conversion of the fore-limbs into wings, the hind-limbs are set on far forward, so that the body may balance properly upon them. And, for their support, there are very long hipbones united to a region of the backbone (sacrum) composed of a number of its joints fused together. In order to further rapid progression when on the ground, the legs are fairly long, and this has been brought about much

in the same way as in ruminant mammals. Beginning at the upper end, there is a rather short thighbone (humerus), followed by a long shinbone, an elongated shankbone — comparable to the cannon-bone of a ruminant—and four toes. The little toe has been lost. It will be seen that the bird walks on its toes—*i.e.*, is *digitigrade*, just like a hoofed animal.



289. QUILL FEATHER
Photographed by Prof. B. H. Bentley

The ankle is therefore raised off the ground, and corresponds in position to the junction between shinbone and shankbone. No little irregular ankle-bones are to be seen here, however, for in the interest of firmness half of them have united with the lower end of the shinbone, and half with the upper end of the shankbone. The instep-bones of the second, third, and fourth toes are fused to make up most of the latter.

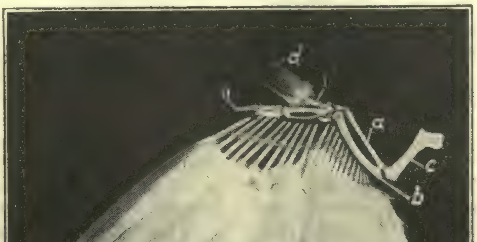


290. SKELETON OF OSPREY
a. Skull *b.* Lower jaw *c.* Radius *d.* Shoulder bones *e.* Humerus *f.* Wrist *g.* Ulna *h.* Ribs *i.* Thighbone *j.* Shin *k.* Shank *l.* Hip-bone *m.* Sacrum *n.* Merrythought *o.* Breastbone *p.* Plough-share-bone i, ii, iii, and iv. Thumb and fingers

Methods of Progression. Most small birds hop, some — *e.g.*, jackdaw — both hop and walk, while others, such as game birds, waders, and rooks, walk. In the flightless running birds, some of which vie with the fleetest mammals in speed, not only are the legs of great length, but we find instances of reduction in the number of toes already remarked among such forms as ruminants. The American ostrich has only three toes, and the African ostrich but two [292], of which the inner one (third) is much larger than the other (fourth). Note also the absence of a keel to the breastbone.

Climbing Birds. In many cases the foot of a perching bird is a grasping organ of sufficient power to be used in climbing without any structural modification. The sharp claws naturally play an important part here. Tits and nut-hatches [286] run up and down the trunks and branches of trees with equal facility. The writer has seen a nut-hatch alight on the surface of a plastered wall, holding on to the slightest irregularities, and maintaining itself in the same position—head downwards—for some time, without any apparent effort. Some of the sparrows, which regularly came to the same window as this particular bird and his mate to receive hospitality, had learned the same trick. When climbing upwards, the short strong tail of the nut-hatch can be used as a prop, and the same is true in a greater degree of the tree-creeper (*Certhia familiaris*). which, when searching for food, regularly begins at the bottom of a wall or tree and gradually works its way up.

In woodpeckers and parrots [282] the fourth as well as the first toe is turned backwards, thus constituting a specialised climbing foot. Some of the woodpeckers have gone further, and have become three-toed by loss of the first digit, while the fourth has become correspondingly efficient. The hooked beak of a parrot is as useful in climbing as in feeding.



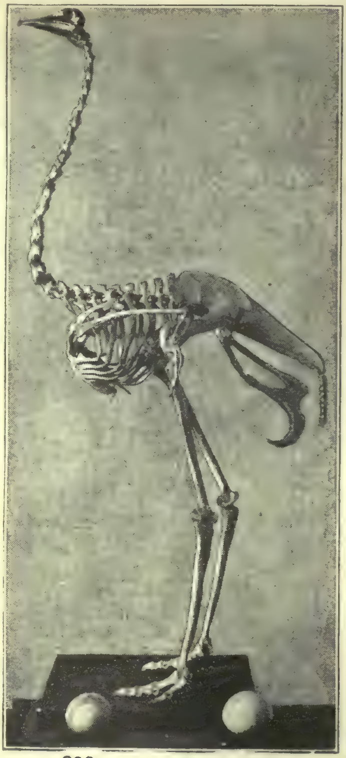
291. WING OF BIRD
a. Radius *b.* Ulna *c.* Humerus *d.* Bastard wing *e.* Primary quills *f.* Secondary quills i, ii. Thumb and first finger

Flight of Birds. Some of the special points in the structure of birds having relation to flight have already been mentioned, but there are still others which demand consideration. The specific gravity of the body is less than in mammals, partly owing to the light and spongy nature of the bones, many of which contain air-spaces. There are also a number of membranous air-sacs in connection with the lungs, by which the same end is furthered. But, in spite of all this, flying involves the expenditure of a vast

amount of energy, in correspondence with which we find that the circulatory organs of birds are of extreme efficiency.

The Nature of Feathers. The surface brought to bear against the air in flight is not a membrane, as in bats, but that offered by the quill-feathers of the wings, which together afford an area of very large extent in proportion to the bulk of the bird [278]. These feathers present the necessary combination of lightness and strength, together with the requisite flexibility. Examining one of them attentively, we shall see that the hollow quill at the base is continued as the axis of an expanded vane [289], the numerous side branches of which (barbs) adhere closely together. The reason of this becomes apparent on looking at some barbs under the microscope, for these will be found to bear still smaller branches (barbules), beset with interlocking hooks. It is the absence of these which causes the plumes of an ostrich or emeu to be of such loose texture.

Attachment of Wings. While in a bat the fingers are much elongated to support the flying membrane, the opposite is true of a bird, in which a firm support is required for the wing quills, sometimes called the rowing feathers (*remiges*). In the structure of the wing [290 and 291] we notice a short, strong, upper-arm bone (humerus), which is succeeded by the two supports of the forearm (radius and ulna) of which one (ulna) bears what are known as the secondary quills. There is a good deal of fusion in the bones of the hand, which consists of only three digits. One of these—*i.e.*, the thumb—bears a tuft of feathers known as the bastard wing [291], which probably helps in the execution of turning movements during flight, while the two others support the primary quills.



292. AFRICAN OSTRICH

Muscles of Flight and Steering. The mechanics of flight is a difficult matter, and can only be treated quite briefly here. The motive power for the effective down-stroke of the wings is supplied by very large muscles, which make up most of the flesh of the breast. Here, too, are situated the weaker muscles which raise the wings, their tendons passing over a sort of pulley to be attached to the upper side of the bone of the upper arm. The wing is pulled down with its under surface sloping upwards and backwards, and part of the force expended goes to support the bird in the air, another part to propel it forwards.

During the downward stroke the wing quills are so pressed together as to offer a continuous surface, but when the wing is raised air is allowed to pass between them, so as to enable the movement to be executed with as little expenditure of energy as possible.

The radiating quills attached to the stumpy tail [278] are known as the steering feathers (*rectrices*), on account of the function they perform. By means of appropriate muscles they can be moved in various ways so as to direct the course of flight, whether straight forwards, obliquely upwards, or otherwise.

Parachuting and Soaring. A bird can use its wings as a parachute for the purposes of gliding in various directions, the simplest case being that of descent. The end of an unsuccessful swoop in a bird of prey, or a corresponding downward movement in other forms, can be converted into an upward glide, much as in the case of the parachuting movements already described for "flying" squirrels.

Some birds, such as vultures, eagles, and crows, are able to sail or soar upwards to all appearance without moving their wings, describing spirals as they do so. An immense height is sometimes attained in this manner. But the precise way in which this is effected still remains to be explained.

Swimming and Diving Birds. The feet of many aquatic birds are converted into effective paddles by the development of a strong web between the toes. This may be seen in a duck or a gull [279], where the three front toes are so connected, and still better in a cormorant [283], where all four toes are united by webs. In grebes the same purpose is answered to some extent by lobed membranous margins to the individual toes. When these swimming feet are moved forward into a position for a fresh stroke they fold up, so as to present as little resistance to the water as possible.

Why Ducks Waddle. With increasing efficiency in swimming powers the legs are shifted further and further back, which diminishes their efficiency as walking organs. This accounts for the familiar "waddling" movements of ducks on land. The peculiarity reaches its extreme limit in the penguins [281], which are more at home in the water than anywhere else. Here, too, the wings are of no use for flight, but are converted into effective propellers, moved with a screw-like action, and covered by scale-like feathers.

Continued

Special Photographs by *Professor B. H. Bentley*


293. Sandpiper


294. Sandpiper on eggs


295. Sandpiper four hours after hatching


296. Black-headed Gull


297. Black-headed Gull. Chicks biting holes in shells


298. Black-headed Gulls just hatched


299. Black-headed Gull


300. Yellow-hammer


301. Blackbird on eggs


302. Hedge-sparrow

WILD BIRDS, NESTS, AND EGGS

[See Natural History]

Special Photographs by *Professor E. H. Bentley*

303. Greenfinch

304. Garden-warbler

305. Linnet

306. Lesser Redpoll

307. Sedge-warbler

308. Song-thrush

309. Song-thrush chicks

311. Chaffinch

310. Young Mistle-thrush

312. Chaffinch on eggs

WILD BIRDS, NESTS, AND EGGS

See Natural History

EARLY FORMS OF BRIDGES

Natural Bridges. Trussed Bridges. Brick and Stone Arched Bridges. Suspension Bridges. Iron Girder Bridges

Continued from page 2430

By Professor HENRY ADAMS

Natural Bridges. The earliest bridge was, without doubt, formed by the accidental falling of a tree across a stream, probably by the scour carrying away the earth and undermining the roots, so that the tree overbalanced and fell on that side. Following the example set by Nature, it is an easy step to form a good bridge for a short span by placing two or more tree trunks side by side across a stream, and we may readily suppose that the branches were lopped off and used in short lengths laid across the trunks to form a very passable footway. A rustic bridge not far removed in principle from that described is shown in **1**. We may grant this much as due to instinct or imitation; it was not engineering. When, however, a wider span had to be crossed, so that some form of trussing was required, the necessity for invention arose, and with it the first bridge engineer.

Trussed Bridges. The simplest kind of trussing, and probably the earliest, would be what we now call in its developed form *a king post truss;* but for stiffening the bridge no struts were wanted, so that with the addition of a handrail it would appear in the form shown in **2**. A greater interval as regards intelligence seems to exist between this form and the inverted truss [**3**], but we may account for its first origin by the overturning of one of the other trusses, and then the happy thought that instead of one of these on each side of the bridge, a series might be laid side by side to form a wider bridge, and so enable heavier traffic to pass from one side to the other. From these two forms it is a short transition to the more complex forms of the *queen post truss* [**4**] and the corresponding *inverted truss* [**5**]; and the observed effect of a travelling road in depressing one strut and raising the other would lead to the cross-bracing in the central bay [**7**]. An early type of timber bridge was one built in Glasgow, in 1832, in 34 ft. spans, as shown in **7**. It is very simple in construction, and upon the same principle as the ordinary stone-yard gantry. Many timber bridges of this character exist across canals in various parts of the country, and there are also some across the upper reaches of the Thames. We need not trace the gradual improvements that were made even if it were possible; it will suffice to notice the modern form of timber bridges for large spans, used principally for pioneer work in America, and shown in **8** and **9**. In some of the larger spans wrought-iron rods or long bolts are used for the tension members; they overcome in a very simple manner the difficulty of framing timber to withstand tensile stress. Some of these bridges are covered by wooden roofs.

Brick and Stone Arched Bridges. To avoid the frequent renewal of bridges owing to the decay of the timber, or the accidental destruction by fire, brick and stone arched bridges have been in use from very early times, and some beautiful structures have been erected. In London we have Waterloo Bridge, of granite, with nine elliptical arches, all of 120 ft. span and 35 ft. rise; and London Bridge of granite, of five spans, the centre one 152 ft. 10 in. span and 37 ft. 10 in. rise, as shown in **10**, and the other spans somewhat smaller. This bridge was erected at an original cost of nearly half a million sterling, and has recently been widened by extending the footway over stone cantilever brackets on each side. A stone bridge of 200 ft. span over the Dee at Chester is shown in **11**. The largest masonry arch bridge in the world is the viaduct at Plauen, in Saxony, which bridges the valley of the Syra, and was only recently completed. It has a clear span of 295·4 ft., and a rise of 59·04 ft., and carries a roadway 36·8 ft. wide with two pathways each of 9·84 ft. width. The arch forms a composite curve, being struck from five centres, the crown having a radius of 344·4 ft., the springings 192 ft., and the haunches 98·7 ft. radius. It was designed for loads which include a train of 15-ton waggons, or of three steam rollers, weighing 23 tons each. The arch ring is built of bluish-

1. SKETCH OF RUSTIC BRIDGE

grey stone from the Theuma and Tippersdorf quarries, laid in cement mortar. At the springings it is 13·12 ft. deep, and at the key 4·92 ft. deep. The work was started in August, 1903, and completed in the summer of 1905, the total cost being about £29,500, inclusive of about £1,000 spent in land purchase. The largest brick arch bridge is the Great Western Railway bridge over the Thames at Maidenhead, with an elliptical arch having a span of 128 ft., and rise of 24 ft 3 in.

Suspension Bridges. "Next to a common log or beam, the most simple and easy contrivance for establishing a constant communication from bank to bank of a river, or between projecting portions of an intervening gap, is that of a rope or flexible line; indeed, the necessity must have given birth to the idea." (Warr.) In India and South America animal hide and vegetable fibre were the chief materials employed, but in Bhootan, north-east of Hindustan, there is a suspension bridge with iron chains of such antiquity that its origin is lost in fable.

Another ancient iron-chain suspension bridge exists in the Yun-nan province of China. In Europe they do not appear to have been used before the eighteenth century. The first in England was built over the Tees, near Middleton, in Yorkshire, about 1741. It was nearly 70 ft. long and only 2 ft. wide, consisting of a footway laid on chains stretched nearly straight. This is probably typical of the earliest forms, the later method being to suspend the footway by vertical bars of different lengths from the curved chains, so that it may be kept level throughout, and the chains being hung with a greater dip are under less tension. The reduction of stress is directly proportional to the increase of dip, except for the extra weight of metal due to the greater length round the curve.

A chain of uniform weight hanging freely takes the shape of a *catenary* curve, while if the weight be distributed uniformly over the horizontal width of span the curve will be that of a *parabola*. In practice the shape is usually that of a *modified catenary*. The great bridge at Freiburg, shown in **12**, was 807 ft. span and 65 ft. deflection. Each of the main suspension cables, 5½ in. in diameter, was composed of 1,056 lines of wire 0·12 in. diameter, passed through a boiling mixture of linseed oil, litharge, and soot, to prevent corrosion. The Menai suspension bridge, 580 ft. span, with a deflectlon of 43 ft., consists of 16 chains in four groups of 4, dividing the bridge into three lines of way, the central 4 ft. wide for foot passengers, and the two outer each 12 ft. wide for general traffic. The 16 chains were composed of links or bars of wrought iron in sets of five, 10 ft. long, 3½ in. broad, and 1 in. thick, with a hole 3 in. in diameter bored in each end for the connecting pins. The entire cross-section, therefore, consisted of $5 \times 16 = 80$ bars, with a total sectional area of $80 \times 3\frac{1}{4} \times 1 = 260$ sq. in. The Hungerford suspension bridge, first erected over the Thames and now placed over the Severn at Clifton, is 702 ft. span with 50 ft. deflection. In its present position it has a very fine appearance, owing to the height of the banks upon which the towers are placed, and although the rise of the tide reaches to 36 ft., there is ample headway for ships to pass under without lowering their masts. The Saltash Bridge over the Tamar, near Plymouth, is a unique structure designed by I. K. Brunel. It consists of two spans, each formed of an elliptical iron tube, arched upwards and braced by wrought-iron rods to chains dipping similarly to those of a suspension bridge. It is, in fact, a suspension bridge with the pull of the chains resisted by the overhead arched tube instead of by anchor blocks buried in the ground on either side.

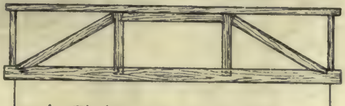
Iron Girder Bridges. The earliest iron bridges naturally took the form of simple beams, but the limit of strength for this form was soon reached. The experiments of Fairbairn and Hodgkinson showed that hollow beams could be built over much greater spans, and following up the principles they discovered, they constructed the Conway and Britannia tubular bridges, like a long rectangular tube with flat sides and cellular top and bottom, the Britannia bridge over the Menai Straits being shown diagrammatically in section by **13** and in pictorial elevation by **14**, where the greatest span is 460 ft. in the clear. Bridges of this type, although based upon sound principles, did not meet with much favour, owing to certain drawbacks involved. They are in effect iron tunnels, are difficult to protect from corrosion inside on account of the steam from the locomotive engines, and outside from the sea air. They also present a continuous surface of great area to the force of the wind, and the positions where bridges of such span are required are usually very exposed. The improvements introduced in the construction of modern bridges will be dealt with subsequently.

Cast-iron Bridges. About the same time Telford was constructing cast-iron bridges, of which Southwark Bridge over the Thames at London is the finest example. It is the largest cast-iron bridge, the middle arch having a span of 246 ft. with a rise of 23½ ft. The two side arches are 210 ft. span and 18 ft. 10 in. rise. The arches themselves consist of eight ribs with webs 2½ in. thick and flanges 4¼ in. thick; these are 6 ft. deep at the crown and 8 ft. at the springing, in 15 divisions attached by means of dovetailed sockets and wedges. The spandrils, or spaces between the arch and roadway, are filled up with cast-iron framing of diagonal struts, bearing cast-iron plates, upon which the roadway lies. Other bridges of the same type were built at Tewkesbury and elsewhere. One of the most pleasing was built at Craig Ellachie, over the Spey in Inverness-shire, with a span of 150 ft. and a rise of 20 ft. It may be noted that cast-iron bridges were based upon the principle of the arch, thus utilising the extraordinary compressive strength of the material.

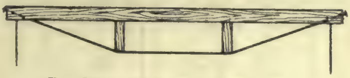
Continued

2. Timber foot bridge

3. Truss for foot bridge.

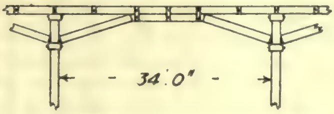


4. Timber road bridge

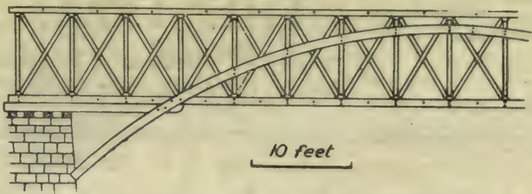


5. Truss for road bridge

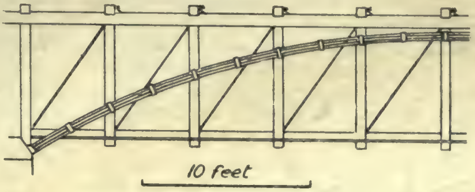
6. Braced truss for road bridge.



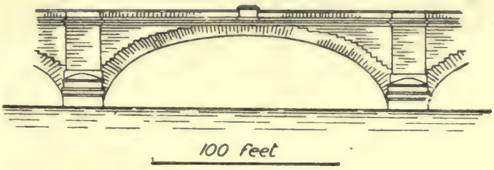
7. Glasgow bridge built 1832.



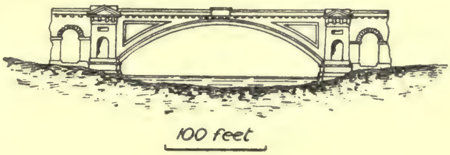
8. Arched truss bridge on Reading Railroad, U.S.A.



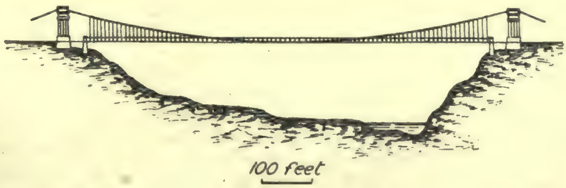
9. Arched truss bridge
on Pennsylvania Railroad, U.S.A.



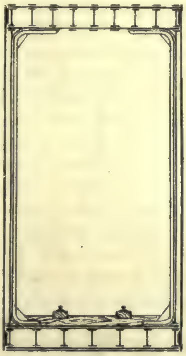
10. London Bridge.



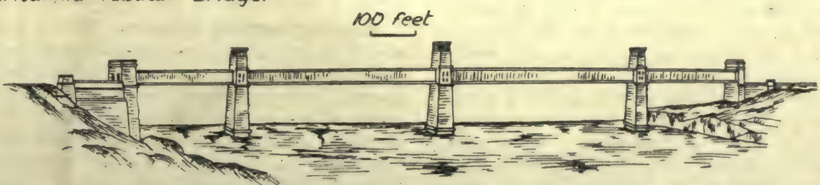
11. Chester Bridge.



12. Freiburg Suspension Bridge.



13. Section of
Britannia Tubular Bridge.



14. General view of Britannia Tubular Bridge.

BRIDGES AND BRIDGE CONSTRUCTION

Group 7 CLERKSHIP 18 Continued from page 2421	THE TRIAL BALANCE

Its Object. Methods of Preparation. Totals and Balances. Errors Disclosed and Undisclosed. Compensating Errors

By J. F. G. PRICE

THERE are in many cases factors other than goods and returns to be taken into account in order to arrive at a true statement of gross profit. For instance, there are the items of freight, duty, carriage, etc., which add very largely to the cost of purchases from abroad. We cannot exactly describe them as "goods," but neither are we at liberty to ignore the bearing which they have upon the question of gross profit.

Trading Account. Evidently, we must have an account more comprehensive in its title than the goods account, one that will embrace all items which directly affect gross profit on trading. At the same time, we require that this account shall be easy of interpretation and analysis, and to that end we must take care that it is simple and concise. Our requirements are met by the "trading account," which, unlike the goods account, is not opened until the end of a business period. Under this plan provision is made for the monthly totals of purchases, sales and returns, which have hitherto been posted to goods account, by raising separate accounts for purchases and sales in the private or in the general ledger. To the debit of purchases account are posted the monthly totals of the invoice book, and to the credit of the same account are posted the monthly totals of the returned outwards book, the difference between the two sides representing net purchases.

Closing the Account. The account is closed by means of a transfer entry passed through the journal and posted to the ledger, crediting purchases account and debiting trading account with the amount of such difference. To the credit of sales account are posted the monthly totals of the day book or sales journal, and to the debit of the same account are posted the totals of the returned inwards book for the period, the difference between the two sides representing net sales. The account is closed by means of a transfer entry passed through the journal and posted to the ledger, debiting sales account and crediting trading account with the amount of the difference. The item "stock in trade" or "stock on hand," instead of appearing in the goods account as heretofore, is now shown in a separate account headed "Stock," the amount on hand at the beginning of a period being on the debit side, in accordance with the rule for real accounts to "debit what comes in." At the end of the period, stock account is relieved of this old debit, being simultaneously burdened with a new debit for the value of the stock on hand as ascertained by stocktaking.

Here, again, recourse is had to transfer entries in the journal. So far as the old stock is concerned, trading account has had the benefit of it, and we therefore credit stock account and debit trading account with the value of the stock at the beginning of the trading period. But with regard to stock on hand at the end of the trading period, it is clear that this must form part of the goods purchased during that period, and perhaps there is, besides, some of the old stock still unsold. We must, therefore, relieve the trading account to the extent of the present value of the whole of the unsold goods reckoned at cost or under; and this we proceed to do by passing another transfer entry through the journal, debiting stock account and crediting trading account. So far, then, we have on the debit side of trading account two items:

(*a*) Stock on hand at beginning of period, (*b*) net purchases during the period; and on the credit side two items: (*a*) stock on hand at end of period, (*b*) net sales for the period.

Other Charges. But in many businesses—the wholesale confectionery business, for example, —freight, duty, etc., must be added to the cost of the purchases before we can arrive at a true balance of gross profit. Accordingly, an account headed "freight, duty, carriage, etc.," is opened in the general ledger, and to this account are posted all cheques and petty cash payments made throughout the trading period on account of imports and other purchases on trading account. If at the end of the period there are any outstanding accounts for freight, warehouse and rail charges, cartage, etc., they must be journalised by debiting the carriage, etc., account and crediting a sundry creditors' account. By this means the whole of the expenditure proper to purchases for the period will be shown regardless of whether it has actually been met or is still due at the time of stocktaking. The account is closed by means of a transfer entry passed through the journal and posted to the ledger, debiting trading account and crediting freight, duty, and carriage account, with the debit balance shown on the latter.

Reproductive Wages. There are, moreover, a great many manufacturing concerns which purchase raw material and expend labour upon it, relying upon the sales of the finished product to return them a satisfactory gross profit. In such cases we should raise a separate account for reproductive, or manufacturing wages. Such wages are called *reproductive* because, although they represent an addition to the cost of the purchases, they also add to the value of the articles offered for sale,

and may therefore be regarded as recoverable out of the sums realised for sales. The manufacturing wages account is thus a part of the trading account, and at the end of the business period will be closed by the transfer of the total net debit to the trading account itself.

Gross Profits. We have now considered the chief ingredients in the trading account. It is a moot point whether cash discounts on purchases ought to be included in the trading rather than in the profit and loss account, but we need not discuss the matter at present. Special notice is to be taken of the fact that the trading account, consisting as it does of an aggregation of the balances of various subsidiary accounts, serves to focus the whole of the business operations throughout a given period which affect the ultimate gross profit. If there is, as there certainly ought to be, a credit balance on trading account, this is the measure of the gross profit earned, and the trading account is closed by debiting the amount of the gross profit thereto and crediting it to the profit and loss account. Where a combined trading and profit and loss account is adopted, it is scarcely necessary to make a journal entry for transferring the gross profit from trading to profit and loss account; it is sufficient, if the upper (trading) portion of the combined account is balanced off by placing the gross profit balance on the debit side thereof and bringing it down on the credit side of the lower (profit and loss) portion of the combined account.

The Trial Balance. Before proceeding to deal further with the balance thus transferred to the profit and loss account, it will be well to retrace our steps a short distance for the purpose of considering in greater detail than we have yet done the table of debits and credits on page 490. That table, or trial balance, consists of a list of all the accounts in the ledger of X., as exhibited on pages 489 and 490, with the totals of the debit and credit entries made on each account shown in two columns. The trial balance proves the correctness of the statement that as every debit in the ledger has a corresponding credit for a similar amount, the total of all the debits must at any time equal the total of all the credits.

Upon reference to the table it will be seen that there are three accounts—A, B, and C—with the same amount entered on the debit as on the credit side. This being so, the agreement of the gross totals of debits and credits will not be affected if these accounts are altogether omitted, since both gross totals will be decreased by the same amount.

This principle may be taken a step further and applied to the cash account. The sum of the debits on that account is £1,145, whilst there is £20 on the credit side. If, therefore, £20 be deducted from both sides, the cash debits will become £1,125, and the credits nil. This operation, also, has no effect on the agreement of the gross totals, since each of them is reduced by the same amount—*viz.*, £20.

The observant student will perceive that the amount now included in the debit column of the trial balance under the head of cash is the balance of the cash account given on page 489, such balance being obtained by deducting the lesser side of the account from the greater.

Total and Balance Methods. The facts just considered point to two conclusions:

(1) That those accounts which have the same total amount on the debit as on the credit side may be omitted from the trial balance.

(2) That it is necessary to include in the trial balance only the balances, and not the totals of the remaining accounts.

To show quite clearly that we are justified in arriving at these conclusions, and that the omissions may safely be made without impairing the usefulness of the trial balance, the careful attention of the student is directed to the table on the following page, showing side by side the two methods.

This table should enable the student easily to understand why agreement is obtained between the totals of the debit and credit columns of a trial balance consisting of the balances of ledger accounts, since it shows clearly that the balance of an account is the amount remaining after deducting the same amount from each side. Thus, in the case of "Bank," the amount of the smaller side—the credit—is deducted, leaving £414 3s. 2d. in the debit column, and nothing in the credit column. In the case of "Sales," the smaller amount being in the debit column, the sum of £152 10s. 0d. is deducted, leaving nothing to debit, and £6,547 10s. 0d. to credit.

Closed Accounts Omitted. It is obvious, having regard to the amount of the purchases and sales, that all the accounts in Smith & Jones' ledgers have not been brought into the trial balance. Our personal accounts number only eight in all, while the transactions to which they relate amount to only some £1,700 to £1,800. The only reason for the omission of the rest of the personal accounts is consideration of space, and their non-inclusion does not affect the agreement of the gross totals, since their debits and their credits must be equal.

The plan of preparing the trial balance by showing the totals rather than the balances of the several accounts has only one real recommendation, and even that is not applicable to modern methods of bookkeeping. When every transaction was entered in detail in the journal and posted thence separately to the ledger, the trial balance on the total system provided an additional check on the accuracy of the work, in that the gross totals agreed with the totals of the debit and credit columns of the journal. As we have seen, however, modern requirements have forced the business community to adopt labour-saving devices in regard to accounts as in other matters. The existence of several journals would render the obtaining of such a check somewhat difficult, and the result would hardly justify the labour entailed.

The Balance Method. But there is another and more weighty reason for the adoption of the balance system. A trial balance made up of the balances of the open ledger accounts contains within itself all the materials necessary

TRIAL BALANCE EXTRACTED FROM THE LEDGER OF SMITH & JONES, ON 31ST DECEMBER, 1905				
Name of Account.	Totals.		Balances.	
	Debits.	Credits.	Debits.	Credits.
Bank	4,621 17 3	4,207 14 1	414 3 2	—
Cash	87 16 8	74 18 2	12 18 6	—
Stock	1,750 0 0	—	1,750 0 0	—
Purchases	5,250 0 0	105 15 0	5,144 5 0	—
Sales	152 10 0	6,700 0 0	—	6,547 10 0
Wages	725 16 0	—	725 16 0	—
Salaries	357 10 0	—	357 10 0	—
Freight and carriage	146 8 6	—	146 8 6	—
Rent, rates and taxes ..	350 0 0	—	350 0 0	—
Discount	75 14 9	52 13 6	23 1 3	—
Miscellaneous trade expenses..	109 16 2	—	109 16 2	—
A. Black..	206 8 0	5 8 6	200 19 6	—
T. Hall	74 6 3	74 6 3	—	—
G. Brown	199 2 6	2 10 11	196 11 7	—
C. Robinson	220 0 0	220 0 0	—	—
F. White	16 8 3	222 1 1	—	205 12 10
J. Harris	62 10 8	62 10 8	—	—
S. Grey	14 9 1	178 19 0	—	164 9 11
W. Green	201 11 6	15 8 5	186 3 1	—
Smith, capital account ..	—	1,500 0 0	—	1,500 0 0
Do. drawing account ..	150 0 0	—	150 0 0	—
Jones, capital account ..	—	1,500 0 0	—	1,500 0 0
Do. drawing account ..	150 0 0	—	150 0 0	—
	£14,922 5 7	14,922 5 7	9,917 12 9	9,917 12 9

for the preparation of the profit and loss account and the balance sheet, with the exception only of the amount of the stock on hand at the close of the trading period.

This reason alone would have been sufficient to bring about the adoption of the balance method, in preference to the total method; but when it is realised that there are in a business of moderate size many accounts where both sides agree in total—*i.e.*, where debits equal credits—it scarcely needs be stated that the balance method is used by accountants owing to the amount of labour saved by their being able to omit such accounts from the trial balance.

Object of Trial Balance. It is the desire of every trader to ascertain periodically (1) what are his profits or losses; and (2) what is his present position as regards assets and liabilities. To obtain the answer to these questions, he must prepare a profit and loss account and a balance sheet. But before he commences to do this he must first know that the work of recording his commercial transactions in his books has been correctly performed. The trial balance goes a very long way toward giving him this information, and it is, perhaps, no exaggeration to say that when a merchant or his accountant arrives at an agreement in his trial balance, he assumes the correctness of the work as a whole, and proceeds to the preparation of the profit and loss account and balance sheet. It should be mentioned, however, that there are certain errors which are not disclosed by a trial balance, and which may exist, although the gross totals of the latter agree. That is a matter which will engage our attention presently, but which need not detain us now.

The importance of the trial balance in relation to the final accounts—*viz.*, the trading and profit and loss account, and the balance sheet—cannot be over-estimated. Indeed, it needs very little consideration on the part of even a tyro to appreciate the necessity of proving the accuracy of the books before proceeding further. The manner in which the test of accuracy is applied is by the preparation of a trial balance. This, as already shown, consists of a list of all the open ledger accounts, arranged with debit and credit columns, in which are entered the balances. It must be clearly understood that the trial balance forms no part of the general scheme of accounts, and is not entered in the ledger or any other book. It is made up on loose sheets, and its object is to ascertain if the debit and credit sides of the ledger agree.

Errors Disclosed by Trial Balance. If the totals of the debit and credit columns of the trial balance do not agree, it is useless to proceed to construct the balance sheet until the cause of the difference has been ascertained. Before commencing a search in the ledger and other books, the bookkeeper will first make sure that the error is not in preparing the trial balance itself. The casting of the columns must be checked. If this does not result in discovery, the separate amounts must be compared with the accounts in the ledger to see that the balances have been correctly brought into the trial balance, both as regards amount and the column in which they have been entered. The casting of the ledger accounts must be checked to ensure that the balances struck are correct. Where an account has been omitted because both sides apparently agree, the castings must be carefully revised, to see if by chance there is really a balance on the account that should be included. If these steps do not

result in the discovery of the difference, a search should be instituted for an item of the same amount as the difference, as it may be that it has been posted to only one side of the ledger ; or the difference may be halved and a search made for the resulting amount, as it is possible that an item of that amount has been posted to the wrong side of the ledger. In such an event the effect on the balance of the account will be twice the amount so posted.

Other Measures. If none of the above suggestions result in the difference being found it will probably be best to call over the postings of the books of first entry into the ledgers. This, in the case of a large business, is a work of considerable magnitude, and is usually the last step to which recourse is had. In fact, the labour involved is so heavy that a system has been devised by which, where a large number of ledgers are in use, it is possible to locate an error as being in a particular book, and thus save an immense amount of time in the event of the trial balance of the whole of the ledgers not agreeing. This system is known as *sectional balancing* or *self-balancing ledgers*, and will be explained in detail later.

However small the amount of a difference may be, it *must* be traced, as there is always the danger that it represents the balance of two or more errors of large amount, and is not a simple error in itself.

Hints on Posting. One or two hints with regard to the mechanical work of posting, with a view to guarding against errors, will not be out of place here. Care should be taken in forming all figures ; fives, eights, and threes should be quite distinct from one another, as should sevens and nines. The tails of the two last-named numbers should not be carried down too low, or they may be mistaken for ones in the line beneath. Do not enter figures too close to the binding. The writer has a lively recollection of a search extending over weeks for an item of fivepence, which was at length discovered almost out of sight in the bound edge of the book. Care must be taken in the pounds column to keep units under units, tens under tens, etc. In banks and other establishments dealing with large amounts, faintly ruled lines are provided in that column in order that the cashiers may strictly and yet easily conform to this rule. Post all debits first, and do not commence posting credits until the debits are exhausted. If it can be arranged, it is better for one clerk to post the debits and another the credits.

Compensating Errors. It was stated on page 2502 that there are certain errors which the trial balance does not disclose. These may be classed generally as compensating errors. They are so called for the reason that they have a twofold effect. They are the more difficult of detection for the very reason that the trial balance does not reveal them, and search cannot, therefore, be made for them at the time of balancing the books, as their existence is not known. They are brought to light by different means, according to their nature. This will be more clearly understood if we deal with specific instances :

(1) INCORRECT CASH-BOOK ENTRY.

An incorrect amount has been entered in the cash book as received from a customer.

This would not affect the balancing of the books, for the incorrect amount entered as received on the debit side of the cash account will also be entered on the credit side of the customer's account. The error will be discovered when counting the cash for the purpose of checking it with the balance of the cash account. If this operation be carried out daily, as dictated by ordinary prudence, the error would not have serious consequences, as it would probably be discovered before the amount had been actually posted to the customer's account.

(2) WRONG AMOUNT OF PURCHASE OR SALE.

Entry of an incorrect amount in the invoice book or purchases journal.

The amount will be posted to the ledger to the credit of the seller of the goods, and would also be included in the total of the purchases for the week or month, as the case might be, and posted to the debit of the goods or purchases account. This, it is clear, would have no effect on the balancing of the ledger, and would not, therefore, be discovered at balancing time. It would not, however, be discovered so quickly as the preceding instance, for, as we have seen, the balance of the goods account does not necessarily, or even probably, agree with the value of the goods in hand. And even if it did this fact would not lead to discovery at once ; for stock, unlike cash, is not counted daily or even frequently, but at intervals sometimes of as long as twelve months. The error will probably remain undetected until the monthly statement of account is received from the seller and compared with the ledger account before being passed for payment. A similar error committed in the day book or sales journal would be discovered when rendering the monthly statement to the purchaser, who would promptly repudiate liability if he had been overcharged, and who should, of couse, call attention to the error if he has been undercharged.

(3) POSTED OR ENTERED TO WRONG ACCOUNT.

(*a*) An amount posted to the right side of the wrong account.

(*b*) An amount entered to the wrong account.

Obviously, this will not affect the balancing of the books, as the amount appears on the proper side of the ledger. Suppose it be cash received from Y, but posted to the credit of X. The error will be discovered when sending in a statement of account to the former. He would point out that he had not been credited with the payment, and a reference to the cash book would show that the sum had been erroneously credited to X.

If the error arose in the posting of a sale of goods it would come to light in the same manner by charging the person with goods he had not received. Upon hearing from him that he had not

had the goods, a search would reveal the facts, and the error would be rectified by cancelling the debit to him and debiting the actual purchaser. An error in crediting a purchase to the wrong person would be discovered when comparing statements received for payment with the ledger accounts.

If the name of the wrong person has been given in the book of original entry the effect will be the same as in the cases above cited, for the result will be that the debit or credit will still go to the correct side of the ledger, but to the wrong account.

(4) PURCHASE TREATED AS SALE.

This would be posted to the debit of the customer, then included in the total of sales for the month, and posted to the credit of sales or goods account. The double entry principle having been observed, the balancing of the ledger is not affected. It should not be necessary in such a case as this to wait either for repudiation by the supposed customer charged or for the statement from the person who sold the goods. An intelligent clerk would know from the name and address that, instead of being a buyer, the supposed customer is really a seller, and an inquiry would result in the discovery of the error. Further, in a business of any size, a separate ledger would be kept for the accounts of sellers and another (or several) for those of customers. The fact of a new account being necessary for a familiar name should lead to inquiry and the detection of the mistake.

Danger of Double Errors. Owing to the nature of compensating errors, their detection is not a matter depending upon the correct balancing of the books, but rather upon common-sense and the alertness of the clerks in charge. Careless checking of statements of account or failure on the part of a customer to notify an undercharge will result, in the absence of other means of discovery, in an error of this nature remaining undetected. Too much stress, therefore, cannot be laid upon the necessity of a bookkeeper looking upon himself not as a mere machine for recording whatever is put before him, however improbable, but of using his intelligence and making such inquiries as, from the nature of the transaction, appear desirable, in any case where a doubt is raised of the accuracy of the original entry.

In the next chapter the profit and loss and the balance sheet are dealt with. Meanwhile, students are invited to test their progress by working the following exercises, selected from a Grade II. Bookkeeping Paper set by the Society of Arts in 1904.

John Shaw, having opened an account with the Dales Bank, Ltd., by paying in £4,200 to his credit, on October 12, 1903, purchased (by cheque) on the following day, the Duchess Slate Quarry from William Black, the purchase price (after valuation) being —Freehold land and quarry, £2,350; stock of slates, £300; and machinery, plant, tools, etc, £350. The following were his transactions up to November 21, 1903. All moneys received were paid into the bank, and (except where stated) all payments made by cheque.

1903, Oct. 14. Drew and cashed cheque (for petty cash) for £20.

16. Bought machinery from Gray & Co. for £45. Gave them his acceptance, at one month, which was duly honoured.

19. Sold G Hill 3,500 slates at £7 8s. per 1,000.

Bought 2 cwt. of drills from Sheffield Steel Co., Ltd., at £20 per ton.

21. Paid rates, £6 10s. 4d.

23. Sold Parker & Co. 1,600 slates at £7 4s. 2d. per 1,000.

24. Drew cheque £73 7s. 9d. for wages, and paid the same.

Banked cash received for cartage, £4 2s. 6d.

27. Made G. Hill an allowance for 250 broken slates (invoiced on Oct. 19, 1903), and made a claim upon the railway company for the amount.

28. Received cheque from G. Hill in settlement of his account, less 5 per cent. discount allowed.

Bought 3 tons of rails at £5 a ton from Rotherham Forge Co., Ltd.

29. Sold Parker and Co. 1,500 slates at £7 4s. per 1,000.

31. Sold D. Green 4,200 slates at £8 3s. 4d. per 1,000.

Drew cheque and cashed same (for petty cash) for £11 15s. 4d., the petty cash being kept upon the "imprest" system.

Paid manager's salary for the month, £30.

Drew cheque £68 3s. 7d. for wages, and paid the same.

Nov. 5. Received cheque £10 from Parker and Co. (on account).

Bought oil and other stores from Slippery & Co. for £4 10s.

6. Paid Sharp & Co. cheque £21 for legal charges.

7. Parker & Co's cheque for £10 returned by the bankers dishonoured, the bank charges on same being 1s.

Drew cheque £70 8s. 4d. for wages, and paid the same.

Banked cash received for cartage, £7 14s.

Bought 10 cwt. blasting powder at £5 a ton from Dynamite & Co., Ltd.

10. Received cheque from Parker & Co. for £10 (on account).

16. Bought timber from D. Green for £16.

19. Received cheque from railway company for claim (in full) made Oct. 27, 1903.

21. Drew cheque for self for private purpose £20, and cashed same.

Drew cheque £62 17s. 6d. for wages, and paid the same.

Pass the above transactions through the proper books to the ledger; balance the accounts as on Nov. 21, 1903; bring down the balances and extract a trial balance. No profit and loss account or balance sheet to be raised.

NOTE. No particulars being given as to the petty cash cheque for £11 15s. 4d. this amount must be entered in one sum in the main cash book. Wages need not be passed through the petty cash book in this case.

Continued

COURTSHIPS & NESTS OF BIRDS

Meanings of Colours of Plumage and Eggs. Birds as Lovers. Architecture of Nests. Varied Materials. The Cuckoo

continued from page 2496

By Professor J. R. AINSWORTH DAVIS

CLOTHING OF BIRDS

Protection Against Cold. It is important that the body of an aquatic bird should be protected against chilling, which is all the more necessary since the temperature of the blood is higher than in any other animals. This is effected in two ways. There is a good deal of fat below the skin, which plays the same part as the blubber of seals and whales. And, besides this, there is an oil gland under the skin on the upper side of the tail. By means of the beak this is applied to the plumage, which, therefore, never really gets wet. It may also be added that the large amount of air entangled in the feathers prevents the escape of heat from the body, and this applies to birds in general, not merely to aquatic ones.

COLOURS OF BIRDS

The colours of birds can be referred to the same classes as those of mammals, which have already been described [page 2156], and some of them will be illustrated in the later part of this lesson.

Protective Colouration. Protective colouration is exemplified by many eggs which are exposed to view, by most young birds which run from the egg, and by a large number of adult birds of both sexes. The last is more particularly true concerning female birds, which are very often inconspicuous or even dowdy in appearance, their preservation being more important for the species than that of the more volatile males, which do not as a rule play so important a part in the rearing of the young.

313. TURKEYS "IN LOVE"
Photographed by Prof. B. H. Bentley

Aggressive Colouration. Aggressive colouration is seen in some of the birds of prey, which harmonise in appearance with their surroundings, and are therefore not so likely to be perceived by their intended victims. This, however, is not so important as in mammals, for such forms mostly rely upon sudden and rapid flight for securing their meals. Beautiful courtship colours are often to be noticed, generally in the male, as we shall presently see. Warning colouration, advertising powers of defence, are exemplified by some of the noisy and quarrelsome friar-birds of the East Indies, and these serve as models to certain inoffensive orioles, which unconsciously mimic them, and thereby are able to exist in comparative peace and quietness. Black and white recognition markings, as in the case of antelopes, are to be found in many of the plovers, and probably enable members of the same species to know one another at first sight. The jewel-like tints of humming birds perhaps have this significance.

COURTSHIP OF BIRDS

It is only natural that the tender passion, which quickens the sluggish pulses even of cold-blooded amphibians and fishes, should stir to its profoundest depths the restless bird-nature, which lives at an unusually rapid pace. The coy female is courted by devices of the most varied nature. It may be that the male is aided by colours of the most resplendent kind, of which extreme cases are afforded by the bravery of the cock-pheasant [272] and the wonderful tail-feathers of the peacock [269, facing page 2209]. Even the familiar inhabitants of the farmyard illustrate the same phenomenon, as may be seen in the turkey, of which the appended illustration [313] represents two "gobblers" with fully displayed plumage competing for the affections of a hen, the lady in this case appearing to favour the suit of the—to our tastes—uglier lover. Sometimes there is no great difference in the external appearance of the sexes, as in swans, our illustration of which [314] shows a male ardently swimming round his desired mate.

Dance and Song. There are a number of birds in which the brightly coloured or otherwise decorated males execute strange love antics and amatory dances, which are not without their effect on the opposite sex. In many forms comparatively dull plumage is fully compensated for by the possession of powers of song, and such love-ditties constitute for us one of the subtlest charms of returning spring. As among many mammals, the males are particularly combative during the spring, especially in species which are of polygamous habit. A good example is found in a bird of the plover kind, the ruff (*Machetes pugnax*), in which the cock-bird grows a beautiful feather-frill round his neck at the pairing time.

A Female Wooer. It sometimes happens that the rules of courtship are reversed, the hen, in this case the more brilliantly coloured, playing the active part, and paying her suit to the

retiring male. A kind of plover, the dotterel (*Eudromias morinellus*), illustrates this highly indecorous—or, shall we say, "advanced"?—procedure.

NESTING HABITS OF BIRDS

Birds That Do Not Sit. The mound builders and their allies (*Megapodes*), native to the hotter parts of Australia and the islands to the north of that continent, resemble reptiles in the fact that they do not incubate or sit upon their eggs and hatch them out by the heat of their bodies. Some of them simply deposit the eggs in hot sand, while others, such as the brush-"turkey" (*Talegallus*), deposit them in a huge mound of dead leaves and other vegetable matter, the decay of which generates a sufficient amount of heat for the purpose. The young when hatched out are in a very advanced state, and quite capable of looking after themselves, in correspondence with the fact that the parents do not trouble their heads about them. The forms in question appear to be the least highly organised members of the group of game birds.

Care of Eggs and Young. All other birds incubate their eggs, and take more or less care of their young. Even the much maligned African ostrich takes some pains in this direction. A number of females scrape out a hole in the sand, and the necessary heat is supplied by the sun during the day and the cock-bird during the night.

314. A SWAN'S COURTSHIP
Photographed by Prof. B. H. Bentley

Protective Colour of Eggs. It may be remarked in general that eggs which are simply laid on the ground, or in a more or less careless nest in this position, are protectively coloured, and often very difficult to detect on that account. The young run from the egg, and are also protectively coloured. In cases where the nests are cunningly hidden, or situated in inaccessible places, the young are helpless nestlings. Here too, as a rule, but not always, exposed eggs are protectively coloured, while those completely hidden from sight are generally white or pale in hue.

The colours of eggs, however, still require a great deal of investigation, and if many amateurs who at present are merely egg-collectors would seriously turn their attention to the relations of colour to surroundings, their labours would in all probability be amply rewarded. Some of our natural history societies are doing good work in explaining the meaning of structure, form, and colour with reference to habit in various animal groups, and if all would combine to this end much might be accomplished. Simple naming and collecting are waste of time, except as a preliminary to serious research of the kind indicated, or with reference to distribution and general questions of this nature. The student will find our natural history museums, now established in most towns, of the greatest value and assistance in his researches.

Some of the plovers simply lay their eggs among shingle or in stony places, and these are so like mottled stones as to deceive all but very experienced observers. The chicks have an interesting habit of squatting when alarmed, when they become quite as inconspicuous as the eggs. All those who take a special interest in the nesting habits of birds, and have the opportunity, should carefully examine the splendid collection of eggs and nests in natural surroundings contained in the Natural History Museum at South Kensington, an institution which in this and many other directions illustrates the romance of science in an unusually striking manner.

Some Examples from Nature. The common sandpiper (*Totanus hypoleucus*) constructs a careless nest, containing four protectively coloured eggs [293], in the neighbourhood of gravelly streams. The series is here completed by illustrations of the adult bird incubating the eggs [294], and the protectively coloured chick [295] four hours after hatching. Even more interesting are the illustrations of the black-headed gull. First we have the rough nest with three eggs [296]; then the same showing the young birds beginning to chip the egg, probably a unique photograph [297]; next the partly hatched and protectively coloured brood [308]; and lastly a young chick facing an unsympathetic world [299].

Materials and Positions of Nests. The yellowhammer constructs a hair-lined nest on or near the ground [300], while that of the blackbird is lined with grass, and usually to be found in hedges a few feet above the ground [301]. The hedge-sparrow lays her clutch of bluish eggs in a cup-shaped mossy nest, lined with hair and down, and placed in the recesses of a hedge [302].

The nest of the greenfinch, constructed of twigs and wool, and lined with hair, is to be found in high hedges [303]. That of the garden-warbler is to be seen among bushes in gardens, and is constructed of grass, lined with finer materials of similar kind [304]. In small trees and bushes, near open spaces, may be discovered the nests of linnet and lesser redpoll. The former [305] is made of twigs and moss, lined with wool, hair, or feathers, and the latter [306] of twigs and grass, lined with down.

The beautiful hair-lined mossy nest of the sedge-warbler (*Acrocephalus phragmites*) is lined with hair, and either actually suspended among sedges or built in bushes adjoining the water [**307**]. Another type is presented by the nest of the song-thrush, generally placed in hedges, and lined with mud. Illustrations are given of a nest of eggs [**308**] and an advanced brood [**309**] of this bird; also of a fledgling [**310**] belonging to an allied species, the missel-thrush.

Well-built Nests. A distinct architectural advance is seen in the tree-nest of the chaffinch, exquisitely made of moss, lichen, and fibre, lined with hair and down [**311** and **312**]. In this, and many other elaborately woven homes, the sticky saliva is used as a cement. From such a case we may pass to such a beautiful domed nest as that of the long-tailed tit (*Acredula caudata*), where a roof is added to the cup-shaped foundation.

Some of our birds of prey build stick nests with a softer lining, and a careless structure of similar kind is constructed by the wood-pigeon, the white eggs of which may be clearly seen from below through the interstices. The black, ragged nests of the social rook are of similar material, more closely compacted together. Similar, too, is the nest of the magpie, commonly to be found in thorn-bushes, for greater security.

Communal Homesteads. The picucules, or tree-creepers, of South America build nests of the most varied kind, among which are those of the oven-bird (*Furnarius*). These are of clay mixed with fibre, and a sort of antechamber leads to an inner compartment, where the eggs are laid upon a layer of grass. Much more remarkable than these, and probably the most extraordinary outcome of bird architecture, are the communal grass nests of the sociable grosbeak (*Philhœterus socius*) of Africa, in which from one to three hundred pairs combine to produce a compound structure, built round the trunk of a tree, and covered with a common roof, so as to suggest a gigantic mushroom in appearance.

Edible Birds'-nests. The clay nests exemplified by the oven-birds suggest those of similar material constructed under the eaves of barns and the gables of houses by the house-martin, and shaped like half a saucer. The clay pellets are cemented together by saliva. Similar in shape are the edible birds'-nests of the East, but these are entirely made of hardened saliva. They are constructed by swifts, and are highly valued by the Chinese as an article of diet.

The Indian tailor-bird actually sews leaves together into a funnel-shaped nest, and the fan-tailed warbler stitches grass-stems together above its globular nest. It is even said to make a knot in the end of the thread.

Some birds prefer to lay their eggs in places far removed from sight. The sand-martin, for instance, digs out a tunnel in a sandbank, and brings up its young at the end of this upon a bed of down. Somewhat the same is true of the kingfisher, but here the bed is made up of disgorged fish-bones.

Homes Dug Out of Trees. Woodpeckers excavate a cavity in the trunk of a tree, and lay their eggs at the bottom of this, while the nuthatch uses a ready-made hollow for the purpose, and contracts the opening with mud, leaving only just enough space to serve as a door. One of the most extraordinary instances of nesting in a hollow tree is afforded by some of the hornbills of Africa and Asia. Here the hen-bird is actually built in with clay, probably by her mate, who at any rate feeds her with the greatest devotion during the enforced seclusion.

315. PIPIT'S EGGS AND ONE CUCKOO'S EGG
Photographed by Prof. B. H. Bentley

Feathered Foundlings. We have, lastly, the curious habit of brood-parasitism, exhibited by the cow-birds of South America and our native cuckoo, which deposit their eggs in the nests of other birds. These eggs are apparently, at least in the cuckoo, not laid in this situation, but carried there in the beak of the hen-bird. The hedge-sparrow and several other of our native perchers are victimised in this way. An illustration is appended of a cuckoo's egg in the nest of the meadow-pipit [**315**]. The young cuckoo develops more quickly than its unfortunate foster-brothers and sisters, whom it ousts from their legitimate home, shoving them over the edge of the nest to perish. In this inhuman proceeding it is aided by a hollow between the shoulders, which later on disappears. The misguided foster-parents tend the unnatural guest with the greatest assiduity, and have hard work to satisfy its inordinate appetite. The intelligence of birds obviously has strict limitations.

The eggs of the cuckoo undoubtedly vary a good deal in appearance, and it has been asserted that they commonly resemble those of the particular species selected as a victim. This is, however, extremely doubtful, and certainly not supported by the photograph from nature here given.

Continued

continued from page 2413

ADVANCED VIOLIN PRACTICE

Tartini Notes. Graces. Trills. Solo and Double Shakes. Vibrato. Harmonics. Pizzicato Effects

By ALGERNON ROSE

BY this time the drudgery of practice should have disappeared. The player will now seek to extend his time of study, being stimulated by the delightful delirium he experiences as progress is made. This pleasure, however, will depart if he does not continue his self-discipline and adhere to his plan of regular and methodical practice. The fact that, whenever a brilliant violinist appears, he, or she, is proclaimed the disciple of some great teacher need be no discouragement. Whoever excels on the violin is indebted more to himself than to the supervisor of his studies. The most expensive master can only point out the right way. He cannot infuse a divine talent into a dull pupil. When there are so many excellent "methods," the danger is that the student, intent on treading too much in the well-worn footsteps of others, may neglect and lose the ability to analyse his own weaknesses and remedy them by compiling—after studying the course on Theory—his own exercises, as many great fiddlers have done in their youth.

In double stopping the student should endeavour, by bestowing great care on the fingering, to get the intervals well in tune. The bow movements in octave passages, and so forth, are effected solely by the wrist, which is helped by slightly raising or lowering the elbow. Listen attentively to each combination of sound. Many violinists who play single notes well in tune are not so successful in double stopping. When they first began this department of study they did not take the precaution to compel their fingers to press the strings at the right points. They failed to realise that the chief difficulty, as well as the chief charm, of double stopping is correct

Ex. 25.

Ex. 26.

intonation. Thus they contracted a bad habit of making false notes, and lost their perception of the dissonance. This addiction, having taken root after constant repetition, is almost impossible to cure. It therefore repays the student to be very careful at the beginning.

Tartini Tones. In a good violin, when two notes are played in tune together, those sounds are supplemented by another given from the body of the instrument itself. It is deeper than the notes bowed, and resembles the "hum-tone" of a bell which accompanies the "strike-tone." Such resultant harmonics in the violin are known as the *Tartini* tones, so named after the great violinist who first drew attention to them. If this third sound is not audible, it is an indication to the student that his stopping is wrong. Therefore, in practising double stopping, do not listen to the top note only; give more attention to the lower sound. The outline, or melody note, is more capable of taking care of itself. Presumably it is the ambition of the student to prepare himself to play later on some of the most beautiful violin music with instrumental accompaniment. In such compositions he will find double stopping used mainly in cadenzas or flourishes. Meanwhile, the other instruments have a pause of silence. If his intonation is good, his skill will be displayed to advantage; if bad, there will be no kettledrum to hide his defects. The ear of the player can not, therefore, be too scrupulous when learning double stopping. If out of tune, an audience will immediately detect the error, especially in octaves. Playing major and minor scales in thirds is an excellent training in order to get the intervals clearly in succession without using the open strings. The chief trouble is to put the second and fourth fingers into their correct positions, according as the intervals are major or minor. It is of more use to learn to play one scale correctly in double-stopped thirds than to be able to stop all the other scales indifferently.

With a little thought, many helpful exercises [see Ex. 25], to give variety to practice, may be made by the student himself. Ex. **26** is another useful exercise, quoted from Spohr.

The Graces. We now come to the graces, or embellishments. Of these the chief are the *shake*, or *trill*, the *turn*, *mordent*, *appoggiatura*, etc. When "plain," the shake is produced by a simple alternation of two single or double notes executed rapidly. This is easy to do badly, but very difficult to do well. What is called by the Italians a *catena*, or chain, is a succession of shakes. Think of a long trill of a singing bird on successive notes. Try to imitate its clear and even effect. Begin slowly, and increase the speed gradually. When the fingers tire, leave off, and begin again later. When an appoggiatura precedes the note to be trilled, and it ends with a turn, the shake is called "prepared." In the upper positions of the fiddle, where the notes come very closely together,

the student should be careful not to make the sound too sharp.

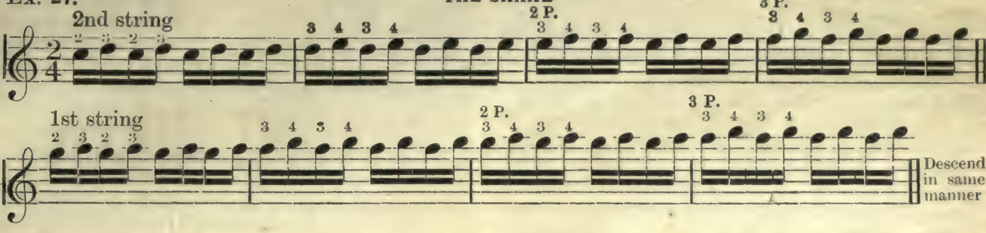
Trill Practice. Trill practice strengthens the fingers. It makes their lowest joints responsive, and gives to them the independence necessary for good violin playing. Great violinists know this; their trill exercise never ends.

Such finger drill can be done without a violin. Place the left thumb against the tip of the first finger, then strike the tip of the second and third, or third and fourth fingers against the palm of the hand. Make the tips strike as far down towards the wrist as possible. Regulate each stroke by the ticking of a clock, or, if in a railway carriage, by the motions of the vehicle. Make the strokes forcibly. Keep the unemployed fingers rigid. As the finger muscles get stronger and more independent, increase the number of strokes to each tick, or the sound by which the practice is regulated. To increase the power of the troublesome little finger, put together the tips of the thumb, first, second, and third fingers. Then make the fourth finger wag backwards and forwards as far as it will go. The motions should be done with regularity and increased velocity day by day.

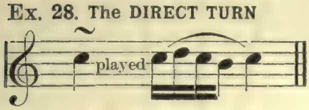
These drills are useful for acquiring that finger-freedom which is indispensable in making a good shake. But such exercises must not be done erratically. After practising at odd moments for a week away from the violin, try the shake on the instrument itself. Record the velocity attained; then continue this independent shake practice. Test the progress made at the end of the second week, and so on. The beats in every shake must be equal. Each finger should be raised high, and descend on the string like a little hammer; but the fingers must go down freely. In trills by semitones there should be no rubbing of one digit against its neighbour. It is useless for the student to think that he can learn the shake in a day. Unnatural force should not be used, and over-exertion must be avoided. There is no better practice than to convert each scale into a chain of shakes. [See Ex. 27.]

Solo Shakes. Never use the first finger during practice in a single shake. Pay particular attention to exercising the little finger. In a solo the shake should always be given its full value in time. To render it as brilliant as possible good players sometimes begin a shake half a beat before the time indicated in the music. The student should devote at least a quarter of an hour every day to playing one or more scales up and down the fingerboard with the slow shake at first, increasing the speed gradually. This may appear wearisome unless the self-instructor remembers Samuel Butler's words that "Drudgery and knowledge are of kin." The latter cannot be gained without paying its price, and this is the surest way of obtaining brilliancy and power in fiddle playing. If knowledge is worth having, aspire to get it completely. Do not be retarded by wasting time over alluring and unprofitable tunes. Such are to be found in many violin methods. These pills, to help the learner, are often so highly sugared that the object in swallowing them is misunderstood, although that should be the first consideration. The learner who cultivates the ability to write out his own exercises can practise the shake in a different way each day.

Ex. 27. THE SHAKE



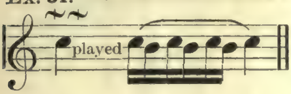
Ex. 28. The DIRECT TURN



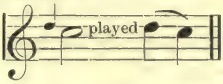
Ex. 29. The INVERTED TURN

Ex. 30. The SINGLE MORDENT

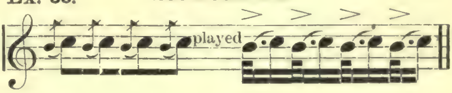
Ex. 31. The DOUBLE MORDENT



Ex. 32. APPOGGIATURA

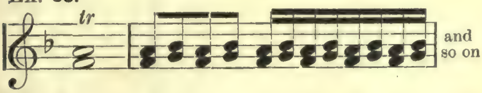


Ex. 33. ACCIACCATURA



Ex. 34. SHAKE combined with DOUBLE STOPPING

Ex. 35.



Turns. Having conquered the shake with single notes, the smaller ornaments will be found easy. The *direct turn* consists of three or four little notes preceding or following a chief note. These are played by the same bow which takes the chief note. [See Ex. 28.]

If the turn is *inverted*, it is marked as shown in Ex. 29.

A *single mordent* is a sharp alternation of the note to be played with the semitone above. The word comes from the French "mordre"—to bite. [Ex. 30.]

When two such signs occur over a note two bites occur before the note is emphasised, the ornament then being called a *double mordent*. [Ex. 31.]

The *appoggiatura* is a little grace-note, either long or short, literally "leaning," or resting against a full-sized note. It does not interfere with the time of the music, the two notes being executed with the same bow in the space allotted for the second. [Ex. 32.]

Lastly, the *acciaccatura* (or "short appoggiatura"), meaning to crush, is a little note with a stroke across its tail, preceding a full-sized note. The former is fingered so quickly that it almost appears to tumble into its neighbour. [Ex. 33.]

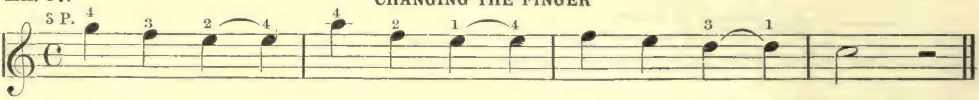
shake must move with the greatest rapidity and regularity; in the second place, the notes of the accompanying part have to enter as precisely as they would do if attention were concentrated on them alone. Ex. 36 illustrates what is meant.

Vibrato. If Stradivarius, before making a fiddle, had to wait five or six years while the wood of the belly was being dried naturally in the air, protected from sun and rain, it is only fair that the player on such an instrument, who is desirous to excel, should have to exercise his patience for a considerable period. Although unsuccessful at first in controlling the finger sufficiently to master the foregoing exercises, they will appear easy to the student if he goes back now to some of his earlier tasks. To each note of a simple exercise the learner should strive to impart a tremulous or impassioned quality of tone. It is the accomplished violinist who can render the simplest tune most beautifully.

The effect known as the *vibrato* is caused by making each finger in succession throb on the string by increasing and lessening the pressure of the finger-tip. The motion which alters the stopping should be very slight, so as not to interfere with the purity of the tone. Practise slowly and steadily at first. Devote ten minutes to this

Ex. 36. *Larghetto.* ♪ = 80. SPOHR.

Ex. 37. CHANGING THE FINGER



The Double Shake. These minor embellishments lead us to the consideration of that extremely difficult ornament the *double shake*. As a preliminary exercise, the pupil is advised to return to the double stopping in sixths, and make a single trill alternately on the top and bottom notes while keeping the bow on both strings. [Ex. 34.]

Now practise making chain shakes with two notes together in thirds, and see that they are in tune. If not, they will be offensive. Begin slowly, listening to make sure of the intonation. Make the beats equal, and increase the speed gradually. On the lower strings shakes are not taken so quickly as on the high ones, owing to the slower vibration. To be effective the shake must be executed literally with "grace." It should be interpolated in a melody with lightness without disturbing the time. Double trills which employ open strings have no turn at the end, We give a useful exercise, which should be continued for two octaves, up and down, and transposed into other keys. [Ex. 35.]

The most difficult of all shakes on the violin is that which necessitates the playing of an accompaniment at the same time, so that the effect is as of two performers instead of one. In the first place, the fingers which execute the

study every day till the vibrato can be produced easily. Give special attention to the weak third and fourth fingers. A long, sustained note may be rendered very beautiful by beginning with the vibrato, slowly and gradually increasing its speed. In old music this effect is sometimes indicated by dots, thus . . . . . Nowadays it is left to the discretion of the player.

It may be noticed that the vibrato is used in four distinct ways. First, it is done quickly, for giving a strong accent to a note. Secondly, it is used for sustaining slow notes in an emotional manner. Thirdly, the vibrato is begun slowly and then quickened, so as to make a crescendo on a long note. Lastly, it is begun quickly, and the throbbing is retarded to make an effective diminuendo.

Tempo Rubato. A refinement of effect in the ingratiating use of the vibrato is a temporary acceleration, or retardation, of the time. This is termed *tempo rubato* (or "robbed time"), when some notes are deprived and others given more than their share of the strict time indicated. But these liberties, although occasionally allowable in solo playing, should be avoided by the student who is preparing to take his place in an orchestra.

Changing the finger on the same note during the same bow is another device for imitating the

human voice. Singers know that, when two syllables of a word spelt differently are sung on the same note with the same breath, the expression of the second syllable is slightly different to the first, the reason being that different vocal cords are employed for their enunciation. Almost an identical effect is elicited from a violin string when the second of two notes linked together is stopped by a different finger. However equal the strength of the fingers may be, there is a subtle change in the tone.

The student should now turn to Ex. **37**.

In the first bar the second finger is drawn back to C in the first position, so that the fourth finger falls down without any gliding sound. This power of inaudibly altering the fingering of one note is important. Success in portamento playing often depends on it. While the change takes place the bowing must be continued delicately, so that no difference in quality can be detected, especially if, in order to continue the same sound, the string as well as the fingering is changed.

marvellous employment of harmonics. His rivals regarded the innovation as "claptrap." To play harmonics with facility, the finer the points of the fingers are the better. Thick, stumpy fingers are not well adapted to such work.

Natural Harmonics. In a full-sized violin, half the free length of the E string will be found about 6 in. from the bridge. After touching this point lightly with the first finger, and getting the octave E on the first string, with the fourth finger find that point which measures off one-third, approximately 4 in., from the bridge. Bow lightly. The resultant sound will be B, a fifth above the harmonic E. Measure off with the third finger that point between the centre and third segment, indicating one of the quarters of the whole, or about 3 in. from the bridge, and find that note which gives the double octave of the open note.

But the finger can be placed lower down the finger-board so that it rests over a corresponding lower third—8 in. from the bridge—or second fourth division—9 in.—of the string. The har-

Ex. **38.**

Ex. **39.**

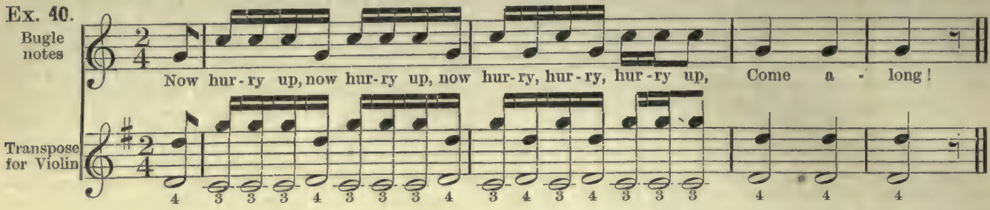
Harmonics. If the violin in finger-changing is capable of closely imitating the singer, it transcends the human voice in another respect. A few accomplished singers with phenomenal range have been able to produce very high vocal notes of a pure and fluty quality, but every violinist can elicit such sounds in greater variety after a little practice. If the fingerboard of the violin is regarded, it will be observed that the free vibration of each string takes place between two fixed points—the nut and the bridge. Now, touch the E string lightly with the first finger half-way between these points. Bow the note softly. The sound heard will be an octave above the pitch of the open string. In quality it is clear and beautiful. In the same manner the string can be made to divide itself into vibrating segments of 3 thirds, 4 fourths, 5 fifths, 6 sixths, and so on. But such sounds are produced most easily from the G string, because it is the deepest in pitch. They are known as *Harmonics*. It was Paganini who first astonished the world by his

monic obtained will be like that at the upper third or upper fourth division, but less clear. By dividing the string into five parts, four similar harmonics can be produced at any one of the notes. They give the double octave of the third of the open note. This ability to choose either position is useful in fingering. That harmonics can be fingered from either end of a fiddle-string may puzzle the student. He has been known to argue that, if he touches the string higher up or lower down, he lessens the vibrating segment. Quite so, if his finger presses the string firmly. But he does not "stop" a note when producing a harmonic, although, touching lightly at a natural point, the whole string continues to pulsate. What is altered are the divisions, or lengths, of the vibrating segments, when the string is partially damped above certain nodes. This causes the higher "partials" of the strings to assert themselves and sound their clear overtones. [Ex. **38**.]

Artificial Harmonics. The foregoing harmonics obtained from the open strings are termed natural, as all harmonics, of course, must be. But when the first finger forms a new nut by stopping the strings firmly, and a disengaged finger lightly touches a node above, the harmonic

Con Sordino. "Sordina," or "Sordino," is the Italian for what we call a violin "mute." The effect, however, is not to render the instrument dumb or silent. It is rather that known in singing as the quality of the "bouche fermée," or shut mouth, when the vocalist closes the teeth

Ex. 40.

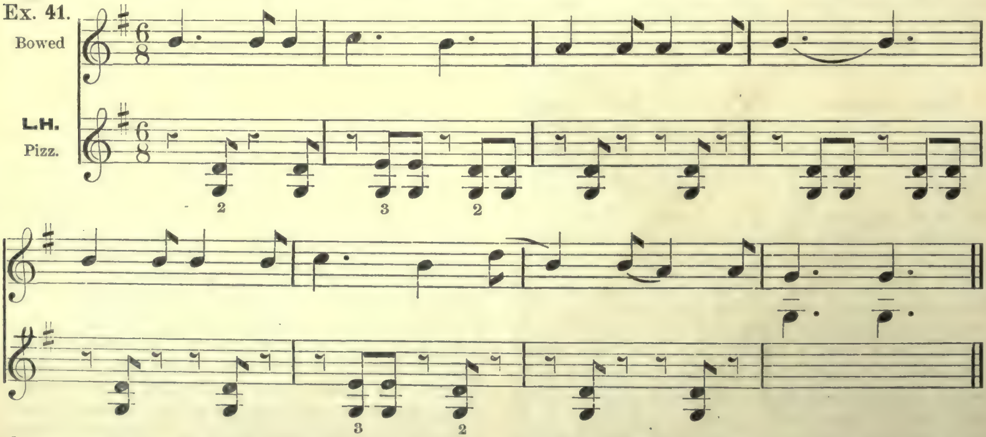


is called artificial. Place the first finger down firmly on C (first ledger line below staff). Let the fourth finger rest very lightly on the position of F, a perfect fourth above the note stopped. Bow the string softly. Instead of F the sound will be C, two octaves above the C stopped by the first finger, because, above the new nut, the shortened string yields the harmonic natural to it. Keeping the first finger in the same place, stretch the fourth lightly over the point for G above the F. The tone will now be G, an octave and a fifth above the note stopped. Practise both the first and second methods of harmonic production. On the G string, a stronger bow can be used than on the gut strings. Extend

and almost the lips. In other words, the violin hums. Its tone is thus diminished when a little extra bridge is fixed over the real bridge of the fiddle, or a penny is inserted between two strings behind the bridge. The quality of sound thus obtained is mysterious and mournful, for which reason the mute is often employed in slow pieces of a pathetic character. When the words "con sordini" or "con muta" occur in the music the mute must be put on. It is taken off when the indication "senza sordino" is reached.

Pizzicato. Pizzicato effects for the left hand are got by plucking one or more strings quickly whilst usually bowing another string. Thus, if all four fingers are stopping the second string in the first position, and the fourth finger twitches the string, the note D, stopped by the third finger, is sounded. If the third finger then twitches the string, C, stopped by the second finger, will sound, or if the second finger twitches, the B, stopped by the first, will be heard. In ascending a scale, the operation is reversed by the stopping fingers being put down instead of taken off. The fourth finger then usually does

Ex. 41.



the series up the scale by semitones the length of an octave. [Ex. 39.]

Excellent practice can be obtained by transposing Army bugle calls a fifth higher, and imitating them. [Ex. 40.]

the plucking, so that the point of contact may be as far away as possible from the place where the sound is checked, the effect being best when the twanging is done by the finger farthest away. [Ex. 41.]

Continued

BRICK AND TILE WORK

Various Classes of Brickwork. Brickwork for Other Trades. Dealing with Old Brickwork. Underpinning in Brickwork. Brick and Tile Paving

By Professor R. ELSEY SMITH

Air Flues. Flues for conveying air into or out of a building in connection with its ventilation are often required. These may vary from large air ducts, in the case of the main flue of a large building, to a small flue formed in the thickness of a wall. The large duct is formed with brick sides and very frequently with a concrete floor and ceiling, and the walls may, if necessary, be plastered. Smaller flues are often formed in the thickness of the wall in the case of inlets, and should be formed without sharp bends or angles where possible, and should, if possible, be rendered [**115**]. Extract flues are sometimes carried up in the same stacks as chimney flues ; in other cases several are gathered into horizontal ducts and thence taken to a vertical flue or upcast shaft, resembling a small factory chimney, which is usually fitted with some mechanical appliance for extracting the air. [See Ventilation.]

Forming Chases in Brickwork. It is often necessary to form a vertical recess in the face of a brick wall, to receive a rain-water pipe on the outer face, or one or more lead or iron water pipes internally. Where such chases are required it is desirable, when possible, to form them in building the wall, both the depth and width of the recess being the multiple of half a brick ; but, especially in the case of internal pipes, it is not always possible to foresee where they will be required, and chases must then be cut ; strong chisels are required, and the bricks are cut by driving the chisel into the brick and levering out the brick required to be removed. It is undesirable to cut brickwork that is newly erected, or, as it is termed, *green,* for this is liable to shake the wall and disturb the brickwork all round.

Chases may be formed for the most part wherever they are required ; but a chase may not be cut in a party-wall so that the back of it comes within 4 in. of the centre of the wall, and they should not be cut close to the angle where two walls are joined. A chase that has been cut in this way will always be somewhat rough on the cut surfaces, but may be rendered, if required, to have a smooth surface.

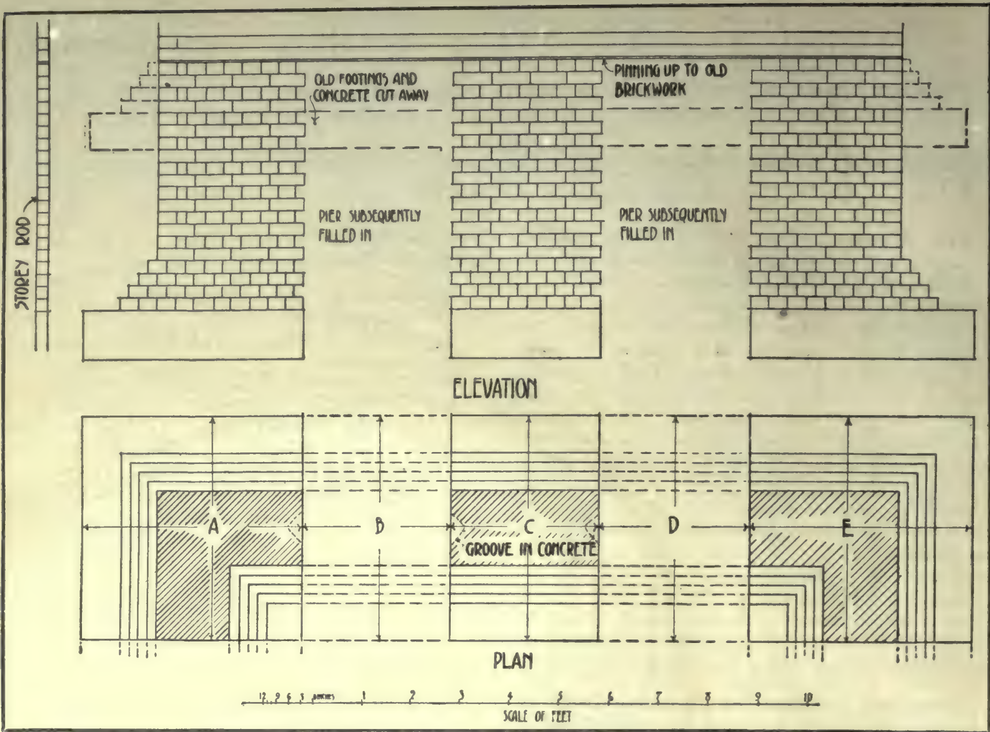
Perforations in Brickwork. Perforations are also required for many purposes in brick walls, as, for example, where the pipe from a w.c. or sink has to be passed through the wall from the interior to the outside. Such perforations are cut with chisels similar but of greater length, where thick walls have to be dealt with. Where the brickwork is old and of good quality the process may be very laborious ; the perforation is made larger than the size of the pipe, and the opening is made good with new brickwork after the pipe is in position.

Building-in and Pinning-in Stones. Very frequently it is necessary to insert in brick walls blocks of stone, which form the sills of window openings or the steps or thresholds of door openings. These may either be *built-in* as the wall proceeds, if they are prepared, or may be afterwards *cut and pinned in.* In the first case the stone is placed in position when the wall has been carried to the proper height to receive it, and a bed of mortar is placed under each end, but it is usual to leave the centre of the stone without any mortar bed. This is termed *hollow bedding,* and the object is to permit the stone more freedom of movement if a slight settlement in the wall should take place, which may often prevent a fracture. When the brickwork is pointed down, on completing the work, all such hollow beds must be carefully filled with mortar, which is worked well into the back of the bed with the trowel. After the block of stone is bedded the building of the wall is continued, the brickwork being cut and fitted round the two ends of the stone.

Where a stone has to be cut and pinned-in the brickwork is cut away as far as is necessary to receive the ends of the stone, which is placed in position on a prepared mortar bed, and the brickwork is made good all round the stone, the cement mortar being forced in between the upper surface of the stone and the brickwork above ; where the brickwork has had time to settle thoroughly before the stone is pinned in, hollow bedding need not be resorted to.

Forming Sand Courses. In the case of stone staircases in which the ends of the steps have to be built into brick walls, and where the steps cannot be built in, it is usual to bed the bricks forming these portions of the wall that will be required to be taken out to receive the end of each step in sand instead of mortar. This allows the wall to be carried up above the sand courses, but permits of the bricks so laid being withdrawn without shaking the wall. It is, of course, essential that the position of all steps to be provided for in this way should be accurately set out, and the steps when inserted are pinned-in in cement mortar, and the brickwork made good round them.

Building-in Iron and Timber. The ends of iron bars are sometimes cut and pinned into brickwork, but this does not give a very good fixing, and, where possible, it is better to let the ends of such bars into blocks of stone built into the wall. This course is usually adopted in all cases in which a considerable strain is placed



114. UNDERPINNING IN BRICKWORK

upon the ironwork, as in the case of the hooks for hanging large gates.

The ends of timbers should not be built into brick walls, as they are apt to decay, but there should be formed, to receive the ends of all such timbers, a recess which will allow a free circulation of air round them.

Preparations for Fixing Joinery. Wherever joinery is required to be fixed, in brick openings or against the face of brick walls, preparation for its proper fixing must be made. A method formerly in vogue, but much less used now, was to build in at intervals wood blocks the size of an ordinary brick; but it was found that such blocks are apt to shrink, become loose, and therefore be unreliable, and in place of them similar bricks made of fine breeze concrete are now used. These are not liable to shrink, and give excellent fixing for nails and screws, but care must be taken if two adjoining faces are exposed giving a salient angle, not to split the brick in driving in nails. Another method is to build-in wood slips. These are thin layers of wood the same size as a brick, about $\frac{3}{8}$ in. thick, and are inserted between two bricks in place of a mortar bed. Being thin, they are not liable to shrink appreciably, and are firmly held by the weight above them; but care is required in fixing joinery to them not to split them. Another method which answers admirably for fixing solid frames is to build into the brickwork iron *holdfasts*, one end split and turned up and down, or else split and spread outwards, the other end bent down and tapped for a screw [116]; this end is left exposed in the face of the brickwork, the frame is fixed by means of a screw to it, and the head of the screw may be counter-sunk. [See Joiner.]

Position of Fixing Blocks. Whatever the means of fixing adopted, points for fixing should be provided in all openings within 12 in. of the top and bottom, and at intermediate points not more than 18 in. apart, and in the case of dadoes, rails, etc., not more than 3 ft. apart horizontally, or more than 18 in. vertically. Where joinery is to be fixed to an old wall the bricklayer must cut a series of holes at similar intervals, into which the joiner drives wedges of hard wood, which are cut off flush with the face of the wall or of the plaster.

Bricklayers' Work for Other Trades. The bricklayer usually beds all wood plates and lintols supplied by the carpenter—*i.e.*, he lays on the surface of the brickwork which is to receive the plate an even bed of mortar on which the plate is laid and levelled. He also beds or builds-in templates, corbels, or brackets of stone supplied by the mason, or of iron supplied by the smith. He also beds door and window frames, and points all round them between the frame and brick reveals in cement; sometimes screeds are formed against the back of the reveals to receive the face of the joinery to be fixed, and this is usually done in mortar formed of one part of lime to three of sand, with the addition of 1 lb. of clean bullock's hair to every 2 cub. ft. of lime, to give it cohesion, as in plasterers' work. [See Plasterer.]

Altering Old Brickwork. The method of toothing new work to old has been already described [page 2268]. Another operation that is frequently necessary is the cutting of a new opening in an old wall. If the brickwork be sound in character, and the opening of moderate size, say 5 ft. or less, the opening may be cut away without any fear of collapse or settlement. An arch, with or without a lintol, is thrown across the opening as for a new arch, and the brickwork above made good to it; the jambs are also, in many cases, rebuilt, or at least refaced. If the work is not sound in character, special care must be exercised, as the cutting away is apt to shake the wall. When possible, a portion of the thickness only, say one-half, should be cut away, the new arch or lintol inserted under this portion, and the whole made good before the other portion is dealt with. If the opening is a wide one, and a girder or bressummer is to be inserted to carry the upper part of the old brickwork, the upper part of the wall is first carried on needles [see page 918], the brickwork is cut away as required to form the opening, and the new girder is then put into position and supported on iron stanchions or storey posts, or by brick piers erected by the bricklayer. When in position, the upper flange is covered with a thick layer of cement mortar, on which slabs of stone are bedded, equal in width to the thickness of the wall above. On these stones a brick wall is commenced as already described, and is built up to the underside of the old brickwork, but no footings are necessary; the work is carefully set out and finished, so that it will support the under side of the old walling, tiles or slates bedded in cement being employed to make up any height that will not accommodate a full brick course. All such work is executed in cement mortar, and the process of finishing the new work tight up under the old, which involves a process of carefully filling in the last joint with mortar from the face of the wall, is termed *pinning-up*.

Underpinning in Brickwork. In underpinning an existing wall in brickwork, the process is, in some respects, similar to the last. A short description of the general process and particulars of the excavator's work was given on page 335. The illustration [**114**] shows an end wall of a building the foundations of which are to be carried down to a depth 5 ft. below their former level. The necessity for this may be due to a failure of the earth below the old concrete, or to provide increased height for a basement. In the first case the old wall will have shown signs of failure, and will have to be shored before the foundations are touched; in the latter case, if the ground be solid in character, the work may be executed without this preliminary in many cases; but judgment and experience alone can determine in any particular case which course to pursue.

The pier A or the piers A and E would, in most cases, be first dealt with. An excavation large enough exactly to receive the new concrete block is made to the necessary depth, and the sides are well timbered [page 330], and the concrete bed inserted, and allowed to set.

The bricklayer, after the new concrete foundation of the first pier or set of piers is in position, sets out the new footings on the top of it, with due regard to the position of the old brick walling to be supported, and erects his wall. This is built of the same length as the concrete foundations, and in erecting it a toothing is formed at the end to receive the intermediate lengths; at the top the wall is pinned up tight against the old one. In constructing other lengths of the wall subsequently, such as the angle pier E, if not carried out at the same time, and the central pier C, care must be taken to preserve the proper horizontal alignment of the different courses, so that when the intermediate portions, B and D, of the wall are built, the whole will bond properly, and form in effect, when completed, a homogeneous wall, properly bonded, and with regular and horizontal courses, and to ensure this, a *storey-rod* [**114**], consisting of a strip of board in which the courses are marked, should be employed, especially if the underpinning be of considerable depth.

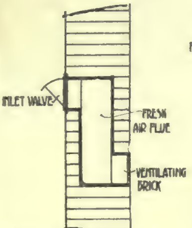
Brick Paving. Brick paving [**117**] is used in various forms. Ordinary stock or other forms of brick may be employed, and laid flat or on edge, and are used for paving coal-cellars and similar positions where there is not much or heavy traffic; they may also be used around the outside of the building to form channels, which are sometimes employed to help in keeping the building dry, and for yards when the traffic is not heavy. In other positions subject to much wear and tear, as in the case of coach-houses and stableyards, *clinkers* [page 1948] are much used for paving. Staffordshire blue bricks of special form [**118**] are also frequently employed, their edges being chamfered to give a reliable foothold for the horses. Some form of hard bed should be provided to receive this paving. It may consist of hard dry rubbish, well rammed or consolidated with a heavy roller; but wherever hard bricks are used, and a thoroughly reliable floor is required, without any liability to become uneven with wear, a good bed of cement concrete at least 6 in. thick should be provided, and the ground below it should be previously well rammed or consolidated.

Laying Pavings to Falls. The floor of any uncovered yard must not be laid perfectly horizontal, or water would lodge on it and not run away, but the surface should be inclined, so that any water will run off to one or more convenient points, where it may be carried off by a drain. This fall should be formed in the concrete bed. This work is described as *laying the concrete to falls*, and requires careful setting out and levelling to ensure that the paving shall at no part be hollow, thereby retaining pools of water. The concrete is usually finished with a floated face in Portland cement and sand, to give an even bed for the bricks. These are bedded in cement mortar; the vertical joints may be filled with mortar as the bricks are laid, or may be kept fine, and when the floor is laid, either dry cement is brushed into the joints, or grout, consisting of cement and sand mixed with an excess of water, is brushed over the floor so as to

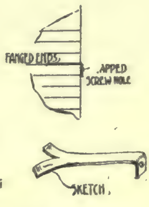
fill up the vertical joints. In laying brick floors, whether the bricks be laid flat or on edge, they may be laid in plain parallel rows, or in diagonal rows, or in the form known as *herringbone* [**117**]. If laid diagonally or herringbone, a plain border of straight bricks is usually formed, which may, if desired, be of a different colour to the other bricks. The best and most even surface of the brick should be exposed, and if it has a frog, this must, of course, be laid face downwards; it is also necessary, to produce good work, that bricks should be selected for uniformity in length, especially in herringbone work, otherwise much difficulty will be experienced in securing a uniform appearance.

Other Forms of Paving. Besides brick paving, various other materials are in general use; in almost all cases, a good bed of concrete is required as a preparation for the finishing surface, and as a rule this is finished with a floated face.

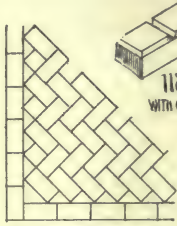
In all cases in which the finished surface is of an ornamental character, care must be taken in arranging any patterns that may be used, so as to centre with the spaces they are to occupy, and in adapting borders to any irregularities in the plan due to projections or other causes. This should be provided for in preparing the design, but the execution depends on the workman, and requires careful forethought and attention.



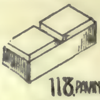
115. AIR INLET FLUE.



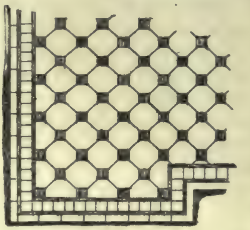
116. IRON HOLDFAST FOR FIXING JOINERY



117. BRICK PAVING LAID HERRING-BONE



118. PAVING BRICK WITH CHAMFERED ANGLES



119. TILE PAVING

AIR FLUES, HOLDFASTS, AND PAVING

Tile Paving. Tiles are very largely used for pavings [119]. They vary greatly in thickness, size, shape, and colour; they may be of one plain colour throughout each tile, and throughout the whole floor, or tiles plain in themselves may be used in various colours to form patterns, or the tiles themselves may be of two or more colours. In places where there is no actual traffic over them—as, *e.g.*, in hearths—the tiles may have a glazed surface.

Tiles are laid on a floated face formed on a bed of concrete; they must be cut, if necessary, to fit irregular positions, are immersed in water for some time before laying, and are laid and jointed in cement. The cement bed should be about ⅜ in. thick to allow of any slight unevenness in the tiles being adjusted.

Mosaic and Marble Paving. Mosaic floors, whether of tile or marble, are set out on sheets of paper, the small cubes of which they are composed being temporarily fixed to the paper so as to form the required design. They are laid in sections upon the prepared bed, rubbed down with large rubbers worked by hand, and polished. *Terrazza* is a somewhat similar paving in which the small cubes are not arranged in patterns. In all cases in which marble is employed, whether in mosaic or in the form of marble tiles or slabs, the bed and the material for setting should be lime mortar, as cement is very liable to stain the marble and discolour it.

Cement Paving. For many purposes cement paving may be utilised; this is usually formed of one part of Portland cement to one of sand, and should be not less than 1 in. thick, as very thin coats are apt to crack and come away from the concrete; if finer work be required the surface may be finished before it is set with a thin coat of neat Portland cement about ⅜ in. thick, but the laying of this should not be deferred till the coarser rendering is set, or it will be liable to separate from it.

For external work the cement paving should be at least 2 in. thick, and may be composed so far as the bulk is concerned of one part of Portland cement to four parts of small shingle free from salt, or of fine granite chippings, and finished with neat cement ⅜ in. thick laid immediately after the coarser stuff, so as to set and become incorporated with it; or with crushed granite mixed with Portland cement, which is known as *granolithic paving*.

Channels and Gutters. If channels or gutters be required in any form of paving they must be prepared for in the concrete bed in such a manner that the full thickness of the paving can be formed at all points in the channel, and still give the required finished size for it.

Asphalt Paving. Asphalt is a good deal used for pavings. It must be prepared for like other pavings, and the surface on which it is laid should be thoroughly dry. It may be laid in any thickness from ½ in. up to 2 in., and if it exceeds 1 in. in thickness, should be laid in two coats, which is always desirable when it is required to be absolutely waterproof. It can be turned up against the walls in a continuous layer, which, in cases where water is liable to collect on the floor, is a great advantage. In road work the asphalt is sometimes laid as a powder and beaten with heated irons, but for floors it is more usual to heat the asphalt as for damp courses, and spread it while hot. [For wood block flooring, see Joinery.]

Continued

A STUDY OF TEMPERAMENT

A Psychological Explanation of Optimism and Pessimism. The Quality of Feeling. The Relation of Pleasure and Pain to Health

Continued from page 2374

By Dr. C. W. SALEEBY

Organic Optimism. Organic optimism is a term which the present writer has already employed elsewhere to indicate that more or less contented, happy state of mind, or state of the conscious self, which depends upon the health of the structures which are concerned with organic sensation. It might be called *gastric optimism*, in order to indicate the large share which sound digestion plays in it, or it may be called *constitutional optimism.* It might be argued that it is more a state of body than a state of mind; nevertheless, the condition of this organic sense of well-being is a never-to-be-forgotten factor of the state of mind at any given time. It is in consequence of this fact that every man in health, as the present writer has said elsewhere, has an *organic bias towards optimism.* Such optimism is, of course, entirely non-rational. It has nothing to do with beliefs or intellectual processes of any kind. We have already seen how, in disease, it is capable of completely outweighing a whole series of beliefs of the most horrible kind, or rather—and this is the all-important point—it may prevent a person from holding and realising those beliefs even when they are forced upon him; for instance, the belief that he has to be fed by a tube, cannot move any of his limbs, and is lying on a mattress in a padded cell. This is a state of affairs in which a perversion of organic sensation may permit a man to be radiantly happy.

Organic Pessimism. Now, it is the fact that a certain measure of organic optimism is the normal state of health; organic pessimism is a state of disease, just as an insane measure of organic optimism is a state of disease. In general, we apply the term *melancholia* to the pessimism witnessed in asylums. But it is, of course, a child's delusion that people can all be divided by a sharp line or by the walls of lunatic asylums into the sane and the insane. The present writer will put this question, which the reader will consider, and to which he may contribute an answer from his own experience—Is there any pessimism which is not really identical with the pessimism of melancholia, and if we examined, or were able to examine, the famous pessimistic writers of the past, such as the two Germans mentioned in last article (both of whom were, of course, admittedly insane) should we not find that the organic sense of well-being was depressed in every case? The answer, which is here strongly suggested as true, though it would perhaps be premature to dogmatise, is that *pessimism, as we know it in the history of thought, is invariably a morbid product:* nay, more, that it must necessarily be a morbid product. This must surely be so, since no one who feels the "glow of health" within him, no one whose organic sense of well-being is in a healthy state, can fail to see that though there is undoubtedly evil in the world, yet there is "much to be thankful for." Of that he has no doubt, since his own state of self-consciousness tells him so, of his own case, immediately and at first hand. It is submitted, then, on theoretical grounds as well as on the grounds that the history of literature and biography lead to the same conclusion, that pessimism is a morbid product.

Rational Optimism. It may further be argued that the facts which we have already cited lead fairly to a rational optimism—that is to say, an optimism which can be defended, not by saying "It is good to be alive, for I feel it so," but by argument and reason. The argument, in short, is that a happy state of mind is normal to health or to healthy life. On the whole, then, life is worth living. Take it on the very lowest ground, and even then we find that the normal exercise of the simplest functions of life—eating and drinking, walking, looking, and even other necessary functions with which the idea of pleasure is not commonly associated—are normally accompanied by a sense of satisfaction which essentially partakes, of course, of the nature of pleasure. Living beings, then, are so constructed that the exercise and functions of life, quite apart from obvious pleasures sought out and attained for their own sake, are yet worth living for. It is the constant amazement of those who are experienced to observe how invalids, whose life would appear not to be worth living, yet cling to it, and are unmistakably seen to derive pleasure from it, provided that the illness is not such as to have interfered with their *organic optimism.*

The Quality of Feeling. It is quite definitely known that there are nerves of pain in the skin, and these have a definite course through the body and within the spinal cord, which definitely distinguishes them from the nerves of touch, of heat, and of cold. But, on the other hand, sensations in general may have a quality which is commonly known as *feeling-tone.* This subject has lately been admirably dealt with by Dr. McDougall, of Oxford. He agrees with every one else that pleasantness and unpleasantness are the two most important forms of feeling-tone. We hear a sound or see an extremely bright light, or have some other sensation and, *in addition*, we may have a sense of pleasure or of pain. This feeling-tone is, in some way, dependent upon the sensations, as Dr. McDougall says, and it "is in a certain degree independent of sensation quality; for one quality of sensation may be at one time pleasant, at another unpleasant, and at a

third have no appreciable feeling-tone. Thus, there is, as a rule, an *indifference point*, which varies very widely, not only for different sensations or different persons, but for different persons at different times."

Pleasure and Pain. It is a further very significant fact that different classes of sensation vary in this respect. Says Dr. McDougall: "The more specialised sensations have comparatively feeble feeling tone; visual sensations, even when very intense, are hardly so unpleasant as a nauseous odour, nor is a pure rich colour sensation so pleasing to most persons as a delicious odour. The organic sensations, excited by changes taking place in the viscera (the internal organs), have the most intense feeling-tone, and these sensations are generally so vague that the feeling-tone predominates over the sensations."

It is not possible to go much further than this in our analysis of the ideas of pleasure and pain. The reader will duly have correlated Dr. McDougall's remark regarding the intensity of the feeling-tone of organic sensations with what we have previously said as to their influence. But the general proposition that feeling-tone plays its greatest part in the oldest and most essential sensations must be very carefully pondered over. It is in accordance with the great demonstration of Herbert Spencer that pleasant states of consciousness make for life, and painful for death. It is the evolutionary treatment of the problem of pleasure and pain which, as in so many other instances, has enabled us to arrive at a solution. The Spencerian proposition is that, in the main, pleasures are beneficial and pains hurtful. Thus, on the whole, when living creatures seek pleasurable experiences and seek to avoid those that are painful, they are seeking the beneficial and avoiding the hurtful. Plainly, those which seek the pleasurable and avoid the painful must thus have an advantage in the struggle for existence over those which do not, and still more over those—if their existence could be conceived—whose tendencies were to seek pain and avoid pleasure.

Pleasure is Life, and Pain is Death. "Sentient existence," says Spencer, "can evolve only on condition that pleasure-giving acts are life-sustaining acts." Thus the fact elsewhere noted by Spencer that "pleasure somewhere, at some time, to some being or beings, is an inexpugnable element of the conception" of good originates in the very nature of sentient existence. "Pains are the correlatives of actions injurious to the organism, while pleasures are the correlatives of actions conducive to its welfare."

Indeed, we must quote from the "Principles of Psychology" a passage now classical: "If we substitute for the word Pleasure the equivalent phrase, *a feeling which we seek to bring into consciousness and retain there*, and if we substitute for the word Pain the equivalent phrase, *a feeling which we seek to get out of consciousness and to keep out*, we see at once that, if the states of consciousness which a creature endeavours to maintain are the correlatives of injurious actions, and if the states of consciousness which it endeavours to expel are the correlatives of beneficial actions, it must quickly disappear through persistence in the injurious and avoidance of the beneficial. In other words, those races of beings only can have survived in which, on the average, agreeable or desired feelings went along with activities conducive to the maintenance of life, while disagreeable and habitually avoided feelings went along with activities directly or indirectly destructive of life; and there ever must have been, other things being equal, the most numerous and long-continued survivals among races in which those adjustments of feelings to actions were the best, tending ever to bring about perfect adjustment."

What Spencer did not Mean. It will be evident to the reader that this is a view the reverse of which has been held by certain people in all ages. To Spencer's law there are doubtless many exceptions—none of which is, in fact, really an exception, but rather a higher proof of the rule. Nevertheless, men have inferred from them—that is, from the existence of mischievous pleasures and beneficent pains—the doctrines that in general pleasures are unhealthy and pains healthy. "They have assumed," to quote Spencer, "that we are so diabolically organised that pleasures are injurious and pains beneficial." "Though every pleasure raises the tide of life, every pain lowers the tide of life." "And though, as every medical man knows, there is no such tonic as happiness!"

This profoundly important psychological truth must not be perverted. It is far from meaning that we are always to avoid anything disagreeable and are always to give the rein to our desires. It certainly does not interfere with the doctrine "that it is good to abstain from certain forms of self-indulgence in order thereby to achieve higher and more enduring happiness."

Is Life Worth Living? Thus we are able, even without the aid afforded us by the modern experimental study of the physical effects of pleasure and pain, to answer the old question as to the balance between pleasure and pain in human life. We need not be guided, as most thinkers have been, by our organic sensation, declaring, according as it dictates, that pleasure outweighs pain, or the reverse. Since we know that the pleasurable is normally correlated with health, and that the painful brings disease and ultimately death—pain being none other than dis-ease—our question is answered. In a word, as every one knows, health and happiness are correlated. It is, indeed, a necessary part of the constitution of all sentient things that pleasure predominates over pain. Only on this assumption are we entitled to declare that life is worth living—which is the assumption that lies at the root of all our morality, otherwise murder would be a duty, and Napoleon, whose criminal lust for slaughter consumed 8,000,000 human lives, would be the supreme saint of history.

Continued

THE ART OF EGYPT

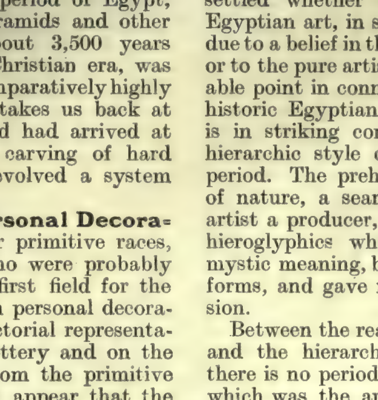
Prehistoric Realism. The Genius of the Ancient Egyptians. Their Temples and Monumental Triumphs. Their Conception of Ornamentation

continued from page 2480

By P. G. KONODY

THE valley of the Nile gave birth to the oldest civilisation of the world. The research of Professor Flinders Petrie and other scientists has proved beyond the possibility of doubt that the art of the early historic period of Egypt, such as it appears in the Pyramids and other monuments, dating from about 3,500 years before the beginning of the Christian era, was preced d by a still older and comparatively highly developed civilisation, which takes us back at least another 4,000 years, and had arrived at consummate artistry in the carving of hard stone and ivory, and even evolved a system of writing.

The Art Instinct in Personal Decoration. Presumably, like other primitive races, the prehistoric Egyptians, who were probably of Libyan origin, found the first field for the exercise of their art instinct in personal decoration; and from the earliest pictorial representations of human figures on pottery and on the walls of tombs, as well as from the primitive painted clay figures, it would appear that the men were in the habit of covering their body with red paint and women with yellow, a custom which, perhaps, was still in force in the early dynastic period. In addition to this, zigzag lines, animals, and symbolic marks were first painted and afterwards tattooed on the body, and a green line painted under the eye with powdered malachite. The palettes used for the purpose of powdering the colour, together with food-vessels, weapons, and all manner of implements, were buried with the dead, and enable us now to form a fairly accurate idea of the life, customs, and art of this remote period. The palettes in particular are carved into the semblance of animals, or have images in relief on the surface. Similar representations of animals are to be found carved on ivory combs and pins and shaped in pottery. In the painted decoration can be found boats, temples, mountains, trees, and human figures, in addition to animals; but there is a notable abs nce of purely ornamental design. The nearest approach to this is to be found in the perfectly symmetrical chip marks of the flint knives, which were fashioned with consummate skill and with a neat finish which was never approached by other primitive races.



9. EGYPTIAN OFFICER OF 4th DYNASTY

The Realism of Early Egyptian Art. Religious belief and the cult of the dead were among the chief factors that led to artistic activity, and it is a point that has yet to be settled whether the earliest manifestation of Egyptian art, in sculpture and in drawing, were due to a belief in the magic power of such imagery or to the pure artistic instinct. The most remarkable point in connection with the art of the prehistoric Egyptian is its absolute realism, which is in striking contrast to the severely formal, hierarchic style of the "classic" or dynastic period. The prehistoric Egyptian was a student of nature, a searcher for truth; the dynastic artist a producer, as it were, of grand, majestic hieroglyphics which conveyed a firmly fixed mystic meaning, but had to comply with certain forms, and gave no scope to individual expression.

Between the realistic art of prehistoric Egypt and the hierarchic art of the Old Kingdom there is no period of transition; but the former, which was the art of the people, overlaps the latter, the art of the rulers. This has been one of the chief reasons for the theory that the classic art of Egypt, which in some of its phases shows a certain kinship with that of Chaldæa, came in the train of Asiatic conquerors who had crossed the Red Sea from Yemen to the land of Punt, and gradually flowed into the Upper and then the Lower Nile valley. The invasion was slow and gradual, and the conquerors absorbed much of the civilisation which owed its origin to the unique natural conditions of the Nile valley.

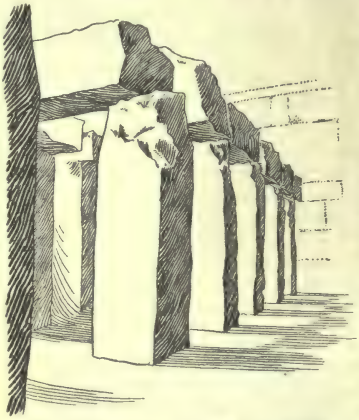
The Impressiveness of Egyptian Art. The genius of the dynastic Egyptian was entirely architectural and sculptural, not pictorial. Everything aims at monumental effect, impressiveness, weight of masses. The mighty pyramids erected over the tombs of the kings; the giant Sphinx, which has been the wonder of countless generations that have stood before it in awe and admiration, unable to solve its eternal mystery; the enormous temples of Karnak and Luxor; the colossal statues of the kings, seated in hierarchic dignity, the very personification of greatness and power—all these are artistic creations that have never been surpassed in grandeur and impressiveness, and were, no doubt, calculated to inspire the people

10.
THE SHEIK
EL BELED

with the consciousness of the superhuman power of their divinities and kings and priests. The mystic element in nature has never found more fitting expression in art, and even at the present day ancient Egyptian motifs and ideas are employed whenever the mysteries are to be suggested.

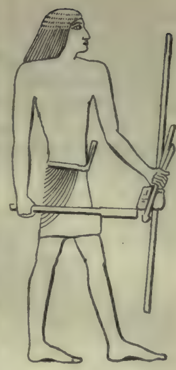
At the very beginning of the dynastic age, wattle and mud were replaced as building material by brick and stone. Both were employed for the building of the Pyramids, which were erected in terraces, diminishing in size towards the top, the steps being filled in from the top downwards until the perfect pyramidical shape was achieved. Within each pyramid is a room, which is reached by a narrow passage and contains the sarcophagus of the king, and a little chapel destined for the cult of the dead.

The Sphinx and Pyramids. Of the grandeur of these Pyramids, and the energy entailed by their erection, some idea may be gathered from the fact that the Pyramid of Khufu, or Cheops, contains some 2,300,000 blocks of stone, each weighing on the average two and a half tons. The colossal Sphinx, the guardian of the three famous Pyramids of Gizeh, is hewn out of a rock embedded in the sand of the desert, which has gradually buried its lion-shaped body, so that only the neck and shoulders are visible. The conception of the Sphinx, with its weird power of mysterious suggestion, is unquestionably the greatest achievement of Egyptian art—nay, stands alone in the art of all times and countries.



12. CAUSEWAY AT THE SECOND PYRAMID

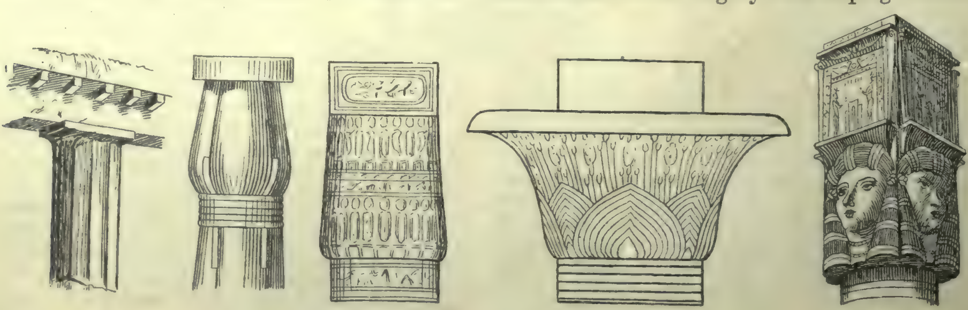
From the beginning of the Third Dynasty, about 3000 B.C., until the end of the Empire, about 1150 B.C., the rulers of Egypt were prodigious in their building activity, but the forms had become stereotyped at an early date; and what progress there is to be noted is only in the direction of greater technical perfection—in sculpture as well as in architecture. Thus the square, unadorned stone pillars, such as were used in the causeway leading to the second Pyramid at Gizeh [12], gradually took the shape of articulated columns. In the rock-tombs of Beni-Hassan, the progress can be clearly observed. First of all, the pillar is given eight facets, then sixteen, and each facet is hollowed out into a groove to accentuate the edges. The architrave is crowned by a cornice and a square slab introduced between the pillar and the architrave. A circular slab connects the pillar with the ground. We have here all the rudiments of the orders of architecture.



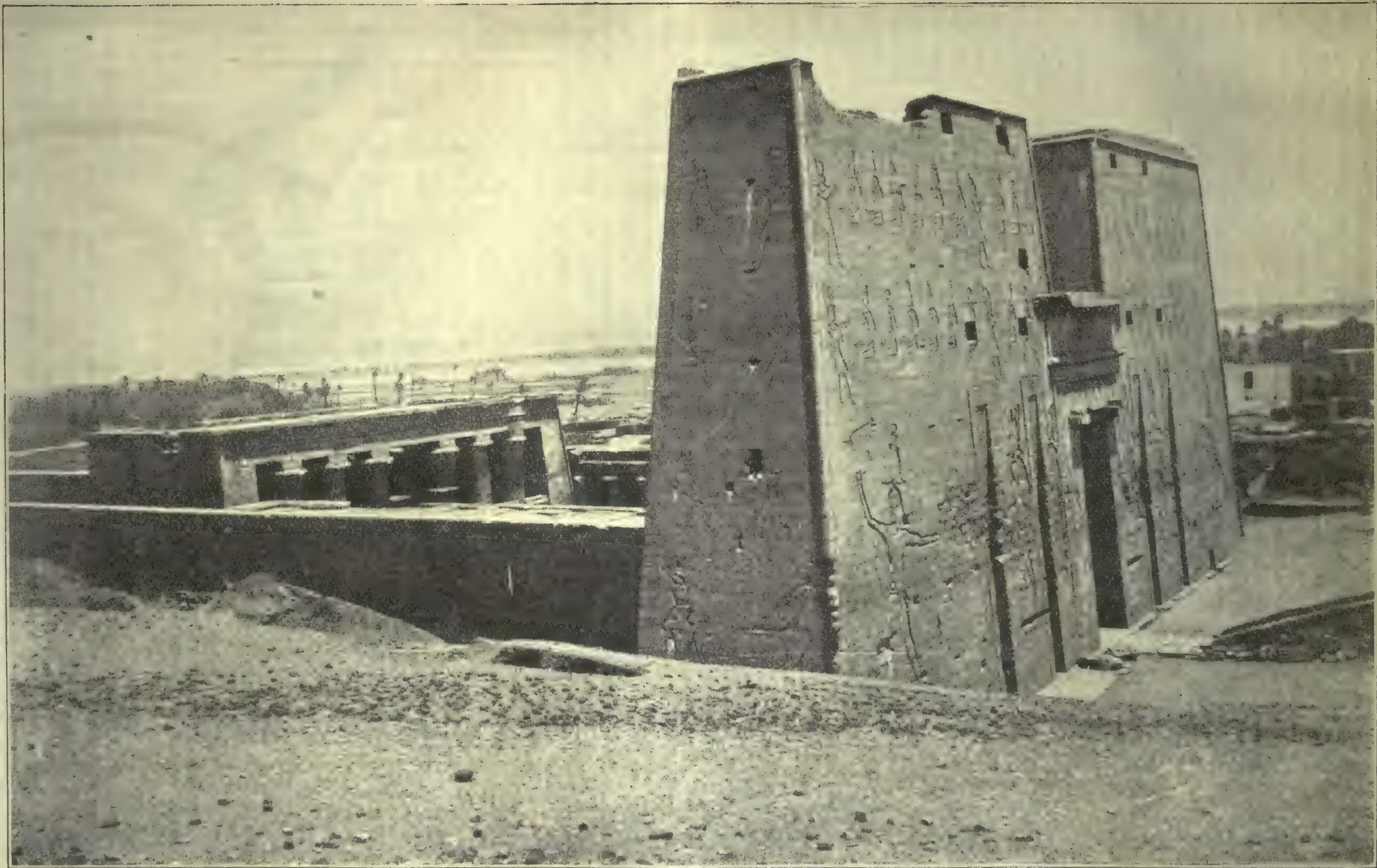
11.
TYPICAL EGYPTIAN
RELIEF FIGURE

The next form is a clear imitation of a plant form—of the lotus. The capital represents a closed flower with four leaves; the shaft, which tapers towards the top, is formed, as it were, of four stalks, which are tied together at the top by ribbons carved out of the stone, and marking the base of the capital. Later, at Karnak, where not only the walls but even the surface of the columns are covered with paintings and hieroglyphics, the lotus form is still further simplified and conventionalised, shaft and capital being perfectly compact and rounded off; but in other columns an important innovation is introduced in the form of a capital representing an opened lotus flower, in which may, perhaps, be found the first suggestion for the volutes of the Ionic capital [13].

The Egyptian Temples. The whole essence of Egyptian art—architectural, sculptural, and pictorial—is embodied in their temples, which were erected on extensive brick terraces raised high above the flat banks of the river, and enclosed within mighty walls sloping towards



13. DEVELOPMENT OF THE EGYPTIAN CAPITAL



14. ONE OF THE MOST IMPRESSIVE RUINS IN EGYPT: THE TEMPLE OF EDFOU

Zangaki

The two great pylons rise to a height of 112 feet. The court, between the pylons and the great hypostyle hall, is surrounded on three sides by a covered colonnade of 32 columns

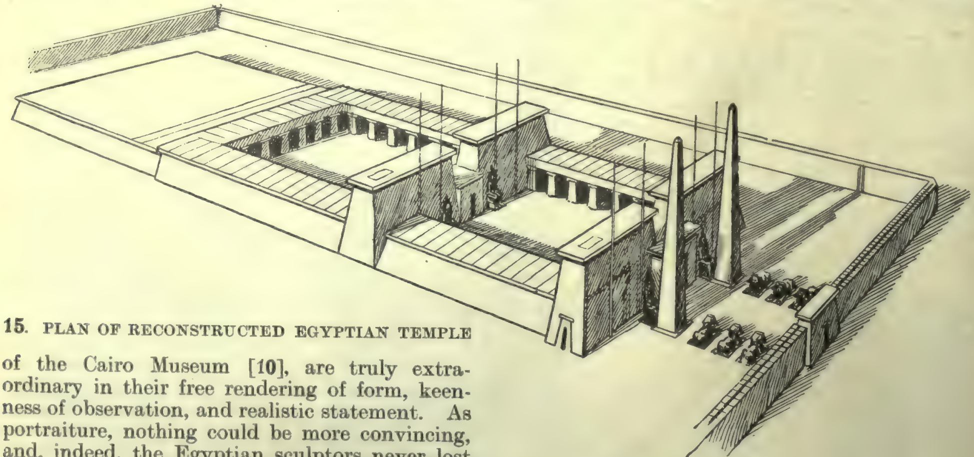
the top and crowned by a grooved, projecting cornice. The very enclosure has a solemn and mysterious effect, which is maintained and enhanced by every feature in the interior. The pyramidal formation of the gently sloping walls, which is consistently carried through the entire temple buildings, not only gives stability but avoids the abrupt angle of a wall rising vertically from the ground, and produces a pleasing effect upon the eye. In the building of country houses some modern architects, like Mr. Voysey, have followed the same principle, with the happy effect that their cottages are not ugly structures planted in the midst of a landscape to ruin it by their inappropriateness, but seem naturally to grow out of the soil.

From the gate on the river-side a symmetrically planted avenue of stone sphinxes, or rams [16], leads to the entrance-gate of the temple, which is flanked by two towering pylons, sloping and corniced like the outer wall [14]. Obelisks and seated royal statues flank the entrance-gate, which leads into an outer court enclosed by covered colonnades. Frequently the same arrangement of pylons and enclosed court is repeated before access is gained to the inner temple, which consists of a mighty stone-covered, pillared hall with a raised central nave, which is provided at both sides with openings for light like the clerestory walls of our churches, and the sanctum with numerous priestly apartments arranged around the mysterious gloomy "cella," the holy of holies, which held the image of the god. All the outer and inner walls, and even the columns and ceilings, are covered with pictorial symbolic representations in rich colours, which still further enhance the powerful impression of these buildings [15].

Early Egyptian Sculpture. The earliest examples of Egyptian sculpture, like the famous "Scribe" in the Louvre and the Sheik El Beled of the Cairo Museum [10], are truly extraordinary in their free rendering of form, keenness of observation, and realistic statement. As portraiture, nothing could be more convincing, and, indeed, the Egyptian sculptors never lost this gift of faithfully recording the features of the person represented, even when the early realism had been ousted by architectonic formulas—the individual by the typical. For well nigh 3,000 years they continued to work according to the rules established by tradition. Again and again they chiselled the seated figures of their rulers, with their legs and feet and arms and hands in perfect symmetry, all in one massive block, the expressionless face looking straight ahead [9]. And the same lack of invention and stiffness is to be observed in the standing and in the kneeling figures—everything is in dignified, stiff repose, without an attempt at movement or expression. The features are recorded with the dryness of a topographic map, as though the expression of human emotions were outside the range of art. During 3,000 years of constant artistic activity no Egyptian sculptor ever thought of raising one of the heels of a standing figure from the ground and letting the weight of the body rest on the other foot. The result is that the action of the muscles plays no part in Egyptian sculpture, and though the muscular forms are at times indicated, they lack all accent and expression; as in the features of the face, there is not a trace of passion and emotion and action, of all that is essentially human. Imposing dimensions have to replace spiritual significance; but there is something intensely awe-inspiring in these gigantic stone images, a suggestion of mysterious power in their grand, lapidary inflexibility.

Pictorial Art of Ancient Egypt. We have already stated that the genius of the ancient Egyptians was essentially architectural and sculpturesque; even their sculpture has an architectural, massive character. Their pictorial art never rose to any degree of independence. It was partly a development of the relief sculpture with which they loved to cover every available space on the walls and columns of buildings, partly an easily intelligible method of writing down their records of historical events and religious mysteries. Painting, in the true sense of the word, was unknown to ancient Egypt. Colour was only applied in flat masses to fill in the outlines of their relief pictures and drawings on papyrus. Even where the walls are not covered with relief decorations, the paintings are treated in the same manner.

The subject matter of these pictorial and relief representations is exceedingly varied, and not



15. PLAN OF RECONSTRUCTED EGYPTIAN TEMPLE

16. THE AVENUE OF SPHINXES AT KARNAK, ORIGINALLY A MILE LONG *Peridisi*
Leading from the Temple of Luxor to the Temples of Karnak

only embraces the religion and daily life of Pharaonic Egypt, but forms a faithful chronicle of historical events. But here, again, everything is hidebound in convention. The king, for instance, must always considerably exceed all other figures in size. The attitudes are more varied than in the monumental sculpture, but have always to comply with certain rules. Thus face, legs, and feet are invariably drawn in profile, but the shoulders and torso full face [11]. Foreshortening and perspective were unknown to the Egyptians, and of composition, in the modern sense of the word, there is never a trace. The figures are placed side by side in long rows, or one above the other. Racial characteristics are well marked in features and costume, but there is no attempt at individual characterisation. In fact, the painting and drawing of the ancient Egyptians was a kind of hieroglyphic language that has little more in common with art than the use of pigments. If the stereotyped forms undergo certain changes in the course of the many centuries, these appear never due to individual initiative, but rather to a general fashion, which demanded, say, different proportions for the bodies. In looking at the ancient Egyptian monuments, reliefs, and wall paintings, one would no more think of the artists who produced them than one would inquire into the name of the compositor who happens to set the type for a modern book—and to a great extent the pictures on the walls of the temples and tombs were the books of the people of that remote period.

Ancient Relief Sculpture. The relief sculpture of the Egyptians had little in common with that of later civilisations. The figures do not project from the level surface of the wall, nor do they show much modelling of the forms. The outlines are merely cut into the stone, and then the background chiselled away to a certain depth, so that no part really projects from the wall. But the painting with bright colours lends the decorated wall the quality of rich embroidery or carpet hangings.

The ornamental motifs of the Egyptians were, in the prehistoric time, chiefly suggested by the patterns of basket-work, and later by the flora and fauna of the country. The lotus and papyrus plants and the winged beetle supplied conventional forms which were not only used with the happiest results by the dynastic craftsmen, but have survived even to the present day. Indeed, certain phases of the modern "art nouveau" movement can be traced back to distinct Egyptian influences. Altogether the art of no other country or period lends itself so well to the suggestion of the supernatural and mysterious; and from this point of view it is worthy of note that in the decoration of masonic temples Egyptian motifs are almost exclusively resorted to.

Continued

CYCLOPÆDIA OF SHOPKEEPING

FISHING TACKLE DEALERS

Unlike certain other trades, the selling of fishing tackle is rather difficult to understand. There is such variety in a complete stock, the nature of which varies so in different districts, that very careful study indeed is necessary to understand exactly what to keep. For instance, we know of a shopkeeper who resolved to add fishing tackle to his business, and wrote to a wholesale firm, who in turn sent their traveller to see him. Thinking that the traveller would know all about the business, the retailer left the selection in his hands, and ordered something like £75 worth of fishing tackle. The goods arrived in due course, and were priced and put on the shelves, and the shopkeeper awaited customers. When the artful angler came to purchase, the merchant found that the articles he had to show were considered utterly useless for the district. Eventually he wrote to the wholesale firm asking them to take the stock, and offering to lose a certain amount on the goods.

Personal Touch. This shopkeeper went the wrong way about the business. In the first place he should have made the acquaintance of a few good anglers in the district and got from them the necessary information regarding the tackle to purchase, and if he had been very energetic he would have furnished himself with an outfit and gone to the streams himself in the company of a good angler. In this way he would have picked up the necessary knowledge of how to purchase, and the kinds of tackle required. No person can go into the fishing tackle trade properly unless he be an angler fishing the various streams and lakes himself. In this way he comes into contact with the angling fraternity, who purchase their requirements from him with full confidence. The writer started this business twelve years ago with little knowledge of it, but by careful study, and by taking every opportunity of getting to the water's edge with good anglers, he soon learnt the art and built up a good business. Later on the scope was extended, and a small workshop was erected with the necessary tools for the repair of broken rods, splicing, fitting new ferrules, rings, etc., and in time every branch was at command.

Capital and Stock. To start a fishing tackle business properly would require a capital of from £200 to £300; but to begin in a small way £75 to £100 would be sufficient, and it should be laid out very carefully, somewhat as follows:

Rods, greenheart, 3 piece, 11 and 12 ft., light fly, with bronzed winch fittings and butt cap, ranging in price from 7s. 6d. to 30s.

Rods, hickory butt, ash centre, and lancewood top, 11 and 12 ft., with brass winch fittings and butt cap, ranging from 3s. to 6s.

Rods, ash and lancewood top, for boys, 9 to 11 ft., from 6d. to 2s. 6d.

Reels, revolving plate, 2 to 3 in., ranging in price from 4s. 6d. to 7s. 6d.

Reels, bronzed crank, 2 to 3 in., ranging in price from 3s. to 4s. 6d.

Reels, brass crank, 2 to 2½ in., ranging in price from 2s. 6d. to 4s.

Reels, brass (American), 1½ to 2½ in., ranging in price from 6d. to 2s.

Rod fittings, brass butt caps, assorted sizes in brass and bronzed butt caps.

Rod fittings, brass and bronzed ferrules and counters, assorted sizes.

Rod fittings, winch fittings, brass and bronzed, assorted sizes.

Rod fittings, German silver, rings, keepers, hitchers.

Rod fittings, end or top rings and steel snake rings.

Lines, best waterproof silk, 20, 25, and 30 yd. boxes.

Lines, plaited hemp, 20, 25, 30 yd., on boards.

Lines, plaited hemp, 40 yd., on boards, for pike.

Lines, barked, for boys, 1d. to 4d.

Floats, cork, egg-shaped, assorted.

Nets, landing, assorted sizes.

Rings, folding, assorted sizes.

Handles, bamboo and ash, 4 ft. long.

Nets complete, with folding ring and handles, to sell at 3s. to 4s. 6d.

Gut cast lines, 3 yd. long, tapered, each 1 × 2 × 3 × 4 × 5.

Gut cast lines, 2 yd., heavy, for bait fishing.

Gut cast lines, 1 yd., heavy, for bait fishing.

Gut traces, 2-swivel, 1½ yd. long.

Gut traces, 3-swivel, 2 yd. long.

Traces, gimp, 2-swivel, 1½ yd. long.

Traces, steel, 2-swivel, 1½ yd. long.

Gut, in hanks of 100, undrawn, heavy, medium, and fine.

Gut, in hanks of 100, drawn, medium, and fine.

Hooks to gut and to gimp, assorted sizes.

Stewart tackle and Thomson tackle, assorted sizes

Pike hooks, double wire, assorted sizes.

Hooks, loose, in 100 packets, assorted sizes.

In flies for streams the following are a good selection for most waters: Teal and red, teal and green, teal and yellow, woodcock and hare's ear, woodcock and red body, woodcock and green body, woodcock and yellow body, March brown (male and female), butcher, Greenwell's

Glory, pheasant back, cow dung, bustard, May fly, July dun, August dun, olive dun, blue dun, whirling dun, grouse and claret, black gnat, blae and hare's ear, blae and yellow.

Flies for lake fishing: Teal and red, yellow and green, butcher, silver doctor, nuen, Greenwell's Glory, woodcock and red, woodcock and green, woodcock and yellow, blae and black, grouse and claret, grouse and green, grouse and organe, Heckham Peckham Professor, pheasant and yellow, Alexandra, sand fly.

Baskets, fishing, white, No. 2, 3, 4, 5, 6.

Books, 6 in., with two pockets, to sell at 1s.. 1s. 6d., 2s., 2s. 6d.

Books, 7 in., with two pockets, leather cover, to sell at 3s. to 7s. 6d.

Minnows, artificial, silk phanborus, assorted sizes.

Minnows, Devon silver, assorted sizes.

Minnows, Devon gold, assorted sizes.

Minnows, Devon bronzed, assorted sizes.

Minnows, screw tail.

Spoon baits, silver back, copper inside, assorted sizes.

Spoon baits, silver back, red inside, assorted sizes.

Spoon baits, with feather on hooks.

Archer spinners, sizes—trout, salmon, pike.

Sinkers, split shot, 1d. boxes.

Swivels, steel, assorted sizes.

Swivels, brass, assorted sizes.

Straps, basket, 1s., 1s. 6d., 2s. retail.

Bags, waterproof, assorted, 3s. to 7s. 6d. retail.

Hooks, gimp, assorted sizes.

Leads, pear-shaped, 3 oz., 5 oz., ½ lb., ¾ lb., 1 lb.

Leads, mackerel, pear shape, 2 lb.

There are other articles in use in certain parts, but this forms a general stock.

Profits. It is necessary that at least 50 per cent. profit should be put on all classes of fishing tackle so as to allow for loss which is unavoidable through having to sell old stock at much less than cost price, and in certain cases having to destroy it altogether. It must be borne in mind that a fishing tackle dealer turns over his stock value not more than once a year.

Stockkeeping. There are various ways of shelving this stock, but the simplest is to get a number of empty collar-boxes, which can usually be procured from any hatter or draper, to cover the fronts with green paper, and to print thereon the names of the different articles contained. In this way the dealer can put his hands on the different articles without trouble, and also save money, because small parcels carelessly kept are very easily lost. One can put about £10 worth of gut casts into a small envelope, so that the advisability of boxes is apparent. A stock of fishing tackle takes up very little room, as most of the articles are very small. It is necessary to be very careful with the buying of all kinds of flies, gut, hooks, gut casts, and loose gut, so that there is a sufficiency for one season only, as any left over until another season may be treated as bad stock. All kinds of gut and flies lose their strength after a time, becoming liable to break, and to an angler there is nothing more annoying than after hooking a fish and playing it a few minutes to find it escape through the tackle giving way.

Sea Fishing. The tackle required for sea fishing is neither varied nor expensive, and requires very little knowledge in handling. £10 to £15 will go a long way in providing a good stock, which ought to be somewhat as follows:

Rods, ash, 2-joint, 9 to 12 ft., varying in price from 2s. to 5s.

Rods, bamboo, 3-joint, 6d. retail.

Rods, 3-joint, 1s. retail.

Lines, hemp, in hanks, 1d., 2d., 3d., 4d., 5d., 6d. retail.

Lines, hemp, on wood reels, mounted with hooks and leads, 6d. and 1s.

Hooks on common hair, assorted sizes.

Hooks on twisted hair, assorted sizes.

Hooks, tinned, in 100 packets, assorted sizes.

Spinners, mackerel, assorted sizes.

Sand eels.

Flies, sea, large, to retail at 1d. and 2d. each.

How to Spend the Money. The relative expenditure upon the various departments of the stock should approximate to the following proportions. We have assumed that £100 is being expended in merchandise, and that the district is one that offers fishing facilities in river, lake and sea:

	£	s.	d.
Rods	£20	0	0
Reels	10	0	0
Lines	5	0	0
Nets	3	10	0
Fittings	3	10	0
Sundries, of which there are a great many	11	10	0
Flies, assorted	10	0	0
Gut casts and traces	10	0	0
Gut in hanks	2	0	0
Gut hooks, Stewart and Thomson tackle	2	0	0
Loose hooks	1	0	0
Minnows	3	10	0
Bags and baskets	2	0	0
Rods, sea	5	0	0
Lines, sea	3	0	0
Hooks and hair for sea fishing	1	10	0
Loose haddock hooks ..	1	0	0
Other baits, floats, leads, flies, etc.	5	10	0
	£100	0	0

Repairing Department. Directly, rod repairs do not pay, as a considerable time is taken up with small jobs which cannot be rushed; but when a gentleman breaks a top-piece or any other part of his rod, his first consideration is where to get it put right, and the dealer who can do this properly for him is rewarded by getting his orders for tackle. Not only so, but he feels so pleased at having got the job done so handy that he has to let all his angling friends know of it and where he had it done, and in this way new customers are secured.

The following is a list of tools required for the workshop and their cost:

1 6-ft. bench, with stop, 15s.

1 bench vice, 12s. 6d.

1 small drilling machine and set of twist drills, 30s.

1 3½-in. centre turning lathe, with set of tools, £5.

1 trying plane, 6s. 6d.
1 jack plane, 5s.
1 hand plane, 3s. 6d.
1 small Stanley iron plane, 2s. 6d.
1 spokeshave, 1s.
An assortment of files from 4 in. to 8 in., say, 2s. 6d.
A few steel scrapers, 2 in. to 4 in., 1s.
1 small gluepot, 1s. 6d. to 2s. 6d.
A few reels of tying silk—red, green, yellow.
A quantity of best coach oak varnish, glasspaper (assorted), mahogany, walnut, and rosewood stains.

FISHMONGERS

The prime essential for the fishmonger is rude health. Without a constitution capable of withstanding the coldest wintry blast, there can be little chance for the ordinary man or woman who intends to make a livelihood at the business, for the necessities of the trade make exposure to the weather in an open shop imperative at all seasons of the year. And the commodities that are handled have to be cool—if not cold—in all seasons, so that the cleaning of fish in the depth of winter, with the thermometer registering 15° below zero, requires a hardihood that is only acquired by fundamental soundness of constitution acclimatised to varying meteorological conditions by years of experience. The business of a fishmonger is often allied to that of a poulterer and game-dealer ; but for the present the vending of the various kinds of fish only will be considered, and game will be dealt with later. Some grocers, and most of the larger departmental stores run fish departments, and in some localities these may be formidable rivals to the young man who essays to secure his living by fishmongery pure and simple. But granted good health, cleanliness, experience in buying and selling, and the attributes of politeness and attention to business—without which no great success can be attained—the trade is one that will repay the exertions of a careful dealer.

Training. This is distinctly one of the businesses in which an untrained person is most likely to come to grief. Occasionally, gentlemen's servants, who have acquired, as they imagine, a more or less intimate knowledge of buying in fairly large quantities for their master's tables, think they know all that is needed to embark in a retail business. There can be no greater mistake, for buying is only one of the many things necessary ; cutting up and selling are totally different, more particularly when the cutting and selling must be done in such a careful manner as to secure a profit sufficient to pay the rent of a shop, the taxes, the help required, the keep of a man—with probably a wife and family to boot—and the saving of a little money for the proverbial rainy day. So the butler who invests his savings in a fishmongery business more often than not invites financial disaster. An apprenticeship, and a full experience in the business, are absolute necessities for success. The best way to learn the trade is from the "basket," so to speak, upwards. Two or three years with a retailer having a brisk family business, and a few more with a good wholesaler in the market, give the necessary insight into the intricacies of the calling, and a knowledge of goods that are as perishable as can well be conceived, and must therefore be handled with the skill and forethought only acquired by intimate knowledge.

Capital and Credit. With a sum of from £50 to £80 in hand, a man well equipped with the other essentials mentioned may make a creditable start. Of course, he would not expect, with such an amount, to rush into fortune in a few years, nor would he look for his shop in a high-class suburb or a West End residential neighbourhood, where monthly, three-monthly, or six-monthly statements of account only would be entertained by his customers. He would select a good middle-class suburb, or the busy thoroughfare of a working-class town, and the bulk of his sales would have to be for hard cash, with perhaps a few weekly bookings. And at the outset he would have to see to it that his weekly accounts did not extend to a fortnight or to three weeks, as accounts have an insidious way of doing if allowed. He must not forget that with so small a capital quick returns are essential, for the wholesaler in the markets, or at the coast, will not give credit for any length of time until the new starter's financial solidarity is assured. Let the limit of credit to the customer, even if his bona-fides be well established, be restricted, therefore, to one week.

The Shop and its Requisites. If the shop selected be not too large and the rent not too high, it will pay the man with an eye to the future to fit it up well. A suitable shop at an annual rental of from £40 to £50 may be secured in a medium-class neighbourhood. No window is required, for the hardy fish-seller must display his wares on cold marble slabs, and brave the elements. The marbled window-ledge and marble shelves are preferably supplemented by a floor of concrete, or tiled or tessellated if the money be sufficient. An ice-box is needed for summer storage. Cleanliness and coolness are two requisites, and nothing looks cleaner or cooler than well kept marble. A slate fish-block, over which a water-tap is arranged, and which is set in a tank, is needed for cutting up and cleaning the fish. This block would probably cost about £5. An arrangement of zinc and wood is often substituted at first, the initial outlay for this being less. Wooden shelving round the shop is also useful, and pails, knives, skewers, weights and scales, and a plentiful supply of paper are necessary. If carefully gone about a sum of £25 will cover all the fittings, even those indicated as ideal, but the beginner will probably not be too lavish with marble slabs and tessellated pavements until he has time to gauge the opportunities for development in the neighbourhood.

Laying in Stock. The fish-vendor must either attend the market daily, if he have one within reach, or arrange with the wholesalers at the coast towns (Grimsby, Yarmouth, Hull, Lowestoft, Plymouth, Peterhead, etc.), for regular daily supplies to be sent direct. Thus, if he happen to pitch his camp in a metropolitan suburb, he will go to

Billingsgate in the early morning with £10 or so in his pocket, and (supposing he start in March) he will probably make a selection consisting of two-stone quantities each of plaice, haddock, hake, codfish, whiting, mackerel, herrings, bloaters, kippers and smoked haddocks. At that season of the year turbot, soles, and salmon are scarce and rather dear, so probably six or seven-pound quantities of these would be found sufficient. Shrimps and oysters are seasonable then, and 28-lb. stocks of these would probably have to be ordered. But it will be understood that the experienced man who has fairly gauged the potentialities of his neighbourhood and who knows the condition of the market will buy the fish that are dear—or are less likely to sell—in smaller quantities, and the cheaper and quicker selling varieties in greater abundance. Besides these, one cwt. of ice must be stocked; this is obtained from the ice companies and does not cost much.

Fish in Season. The following table indicates approximately the months of the year in which various kinds of fish are considered "in season" in this country:

Fish.	In season.
Barbel ..	January, February, March, Oct., Dec.
Brill ..	Each month *except* May, June, July, and September.
Carp ..	Each month *except* October.
Cod	Each month *except* April, May, June, and July.
Chub ..	May and August.
Cockles ..	April.
Crabs ..	Each month *except* June, July, and September.
Crayfish ..	Each month *except* April, September, October, November, and Dec.
Dace ..	January, February, March, and Dec.
Dory ..	April, May, July, and August.
Eels ..	Each month *except* April, May, June, and July.
Flounders ..	Each month *except* May, June, Nov., and December.
Grigs ..	October.
Gudgeon ..	October, November, and December.
Haddocks ..	Each month *except* April, May, June, and August.
Herrings ..	Each month *except* April and Nov.
Lampreys ..	January, February, and March.
Ling	April.
Lobster ..	Each month *except* November.
Mackerel ..	May, June, and July.
Mullet (red and grey)	April, May, June, July, August, Sept., October.
Mussels ..	January, February, March, and April.
Oysters ..	Each month *except* May, June, July, and August.
Perch ..	January, February, March, April, and December.
Pike ..	Each month *except* April, May, Sept., and October
Plaice ..	January, February, March, July, September, and October.
Prawns ..	Each month *except* Nov. and Dec.
Salmon ..	April, May, June, July, and August.
Shad ..	April and May.
Shrimps ..	Each month *except* May, June, Sept., October, and November.
Skate ..	Each month *except* May, June, July, and November.
Smelts ..	January, Feb., March, April, and May.
Soles ..	All the year round.
Sprats ..	January, Feb, March, April, and Dec.
Sturgeon ..	Jan., Feb., March, April, July, and Aug.
Tench ..	Each month *except* May and August.
Thornback ..	Each month *except* May, June, Sept., October, and November.
Trout ..	May, June, and August.
Turbot ..	Each month *except* July.
Whiting ..	Each month *except* May, June, July, and August.

Sources of Supply. Nowadays, all the markets of the country are brought within easy reach of the dealer by the facilities provided by cold storage and by rapid transit from the fishing ports by means of the extensive system of coast and inland railways. Fisheries fluctuate yearly—for example, the herring fisheries in Scotland—but ice-packing and special fish-trains guarantee the freshest of fish always in the metropolis. Herrings are obtained from ports along the whole of the east coast of England, from the English Channel, and to a smaller extent from the Welsh coast and the west side of England. The season for drift-fishery begins on the Northumberland coast in the latter part of July, getting later as one gets southward; for Yarmouth and Lowestoft, October and November are the months; in the Channel, November and December; and in the extreme west, the catch is best in the early part of the year. Thousands of tons of mackerel caught round the Cornish coast are landed at western ports (particularly Plymouth and Penzance), yearly, during the season, February to June. Pilchard comes from the coast of Cornwall and the south coast of Devon, from July to September. Sprats are caught in the Solent, in the estuary of the Thames, and in the Wash (between the Norfolk and Lincolnshire coasts), between November and February. Whitebait are caught in the Thames, while cod, haddock, whiting, coalfish, pollack, bream, and conger are regularly caught round the English coast. The cod fisheries in the North Sea are perhaps the most important.

Off the coast of Scotland the principal catches are herrings, cod, haddock, and ling. The seasons are April and May for the north and west coast hauls, and July to September for the east coast. The principal ports are Wick, Peterhead, and Fraserburgh. Sprats, or garvies, are caught in the Beauly Firth and in the Firth of Forth; while cod, haddock, ling, and saithe (or coalfish), are general round the coast. Cod and saithe are also obtained from the Shetlands and from the Faroe Islands and Iceland. Haddocks are mostly sent from Newhaven and Eyemouth, while the famed "Finnan haddies" (smoked) come from Findon, between Stonehaven and Aberdeen.

Dublin is the headquarters of the deep-sea trawlers round the Irish coast, the principal trawling grounds being between Dublin Bay, Dundrum Bay, and the Isle of Man. The last named spot is favourite ground for soles, and the season is March to July. In January supplies also come from Saltee, near Waterford. Herrings and mackerel are the two most important Irish fishing industries, Howth and Ardglas (June to October) being the headquarters for herrings, while Kinsdale (March to June) supplies the mackerel.

The demand for crabs and lobsters has increased so much in recent years that the supplies round the coasts of Britain have been insufficient and a large quantity is imported from Norway. The English markets are usually

supplied from Cornwall and the south coast of England, the Orkneys and the Hebrides in Scotland, and the west coast of Ireland. Shrimps and prawns are obtained in the estuary of the Thames, Pegwell Bay, near Ramsgate, and Morecambe Bay being the headquarters of the shrimpers. The bulk of the English supplies of oysters are obtained from the beds of private companies—the Whitstable Company being the most ancient. Mussels and whelks come usually from Grimsby. Periwinkles are mainly sent to the London market from the Western Islands of Scotland, from the Orkneys and Shetlands, and from part of the Irish coast.

Prices and Profit. The retail prices to be charged will depend, of course, upon the scarcity or plentifulness of the catch. A few approximate London retail prices would be: cod (whole), 6d. to 8d. per lb., head and shoulders, 6d. to 8d. per lb., middle cut, 1s. per lb., tail, 9d. to 11d. per lb.; haddocks, 6d. to 7d. per lb.; mackerel, 6d. to 8d. each; brill (whole), 10d. to 1s. per lb., cut, 1s. 1d. to 1s. 3d. per lb.; herrings, 1s. to 1s. 4d. per doz.; red mullet, 6d. to 1s. each; plaice, 6d. to 9d. per lb.; soles (slip), 1s. 6d. per lb.; medium, 2s. per lb., lemon, 1s. per lb.; whiting, 5d. to 6d. each; halibut, 1s. 3d. to 1s. 6d. per lb.; flounders, 2s. 4d. to 2s. 6d. per doz.; live eels, 1s. 6d. per lb. The foregoing are all fresh fish; for dried fish, such as sprats, the price would be 1d. to 2d. per bundle; haddocks 7d. to 9d. each; kippers, 1s. 2d. to 1s. 4d. per doz. Shell-fish such as lobsters would sell at about 1s. 6d. each; prawns (large), 1s. per doz., small, 1s. 3d. per doz.; shrimps (picked), 1s. 6d. per pint, brown, 6d. per pint. Native oysters should sell at about 3s. per doz., seconds at 1s. 9d. per doz., and foreign varieties at from 1s. 3d. to 1s. 6d. per doz. The cost price, as before intimated, will vary according to the season and the catch; but it is absolutely necessary that an average profit of from 30 to 35 per cent. on the general turnover should be obtained to make the business go. On herrings, for instance, a direct profit of perhaps 100 per cent. may be on occasion looked for; but on other kinds of fish a much smaller profit is securable and the average should come out not less than the rate stated. Assistance will be required in the shape of a lad to clean up and take out orders, who will have to be paid from 5s. to 7s. per week. As the business progresses it may be necessary to get an assistant, at about 30s. per week, who will canvass for orders and attend to the customers. With good references the young fishmonger will find little difficulty in arranging for monthly credits from the wholesalers in the market or from the fish merchants, if he obtain goods direct from the fishing ports.

FLORISTS

A florist, according to the dictionaries, is "one who cultivates flowers," but in the present article we apply the word, in the sense usually accepted by denizens of towns, to a shopkeeper who sells flowers and plants. In the country, a few florists may cultivate the flowers they sell, but the florist of the big towns buys his flowers at Covent Garden if he is a Londoner, at the flower markets of the various big centres in the country, or has them sent to him daily by large cultivators in various parts of the kingdom. Among the larger growers there is a differentiation in special flowers or varieties. One man is a specialist in chrysanthemums, another in roses, a third in lilies, and so on; and while probably the bulk of the crop of each of these growers may, in England, be sent to Covent Garden, or, in Scotland, to Edinburgh and Glasgow, arrangements are made by country florists for direct supplies.

Learning the Business. The man or woman who sets out seriously to make flower-selling his or her life-work must, therefore, know not only where and how to buy, but how to sell, how to make up, and how to blend. The art of bouquet-making is one in which a fine sense of colour-harmony is a prerequisite. The artistic sense is more or less a necessity to the successful vendor of flowers, for the difference between a combination of floral emblems which demonstrates a distinction and taste in the manipulator and the hastily arranged, clumsily put together bunch is the difference between financial success and pecuniary disaster. Then the preparing of wreaths is an important factor of the business, particularly from a financial point of view, and if this is not properly learnt a significant part of the florist's gain has been forfeited. There are side-lines to the business, such as jobbing gardening—if we may coin an expression—of which the embryo florist should have an insight before starting in business, for jobbing lends itself to considerable development if carefully attended to. The experience necessary for all these things is better gained in a good florist's in a large provincial town rather than in the gardens of a nurseryman or in a purely country business.

Finance and Locality. The capital required to start is not large. Indeed, "a shilling and a basket" is said by facetious members of the trade to be all that is necessary. But we will endeavour to ignore the ubiquitous "flower-girl" of the metropolis who works on the humble shilling system, and assume that our young florist aspires to the dignity of a shop. He (for convenience we will take the male person as typical) has, let us say, not less than £50 to £60 in hand, and he selects a shop in a fairly good-class neighbourhood, the busier the better. It should be remembered that a poor neighbourhood is out of the question, for poor people cannot afford to spend money on flowers, however much they would like to. A small shop, such as would be necessary for a start, would cost in a metropolitan suburb probably from £50 to £70 rent per annum. In the provinces it would be less. But the selection of shop, with probably living premises attached, should be carefully regulated by the purse and the prospects.

Preparing for Stock. The cost of fittings would not be great. A few wooden shelves, a counter, a glass mirror, one or two glass shelves for the window, gas fittings, two

dozen earthenware vases of various sizes for cut flowers, several brass ring or wire ring fixtures for holding pot plants, are all that is required, and would not cost more than £15 all told. The flowers themselves are fine display, and cover up artistically any architectural defects. If the young florist is not fortunate enough to have previously acquired a conjugal partner, he may find it necessary to have a lady assistant (at 10s. to 15s. per week), and in any case, even if he is able to work the business at first single handed, he will need an errand boy (5s. to 7s. per week) to clean windows, sweep up generally, and to take out the orders. March is a good season of the year to make a start, for then one gets a good selection both of cut flowers and plants.

An Opening Order. The shop ready fitted, and the opening day fixed upon, the young florist betakes himself in the early morning (if he is in a London suburb) to Covent Garden. There he would make a selection something on the following lines.

CUT FLOWERS.

Flowers.	Quantity required.	Cost per dozen blooms or per dozen bunches of 12 blooms.	Amount expended.
Arum lilies	½ dozen blooms	4s.	2s.
Lilium longiflorum ..	½ ,, ,,	4s.	2s.
Lily of the valley ..	½ ,, bunches	8s. to 12s.	(say) 5s.
Daffodils	1 ,, ,,	3s. 6d.	3s. 6d.
Violets	2 ,, ,,	1s. 6d.	3s.
Roses (foreign) ..	1 ,, ,,	6d.	6d.
Roses (English) ..	½ ,, ,,	3s. 6d.	1s. 9d.
Azaleas	½ ,, ,,	2s. 6d.	1s. 3d.
Tulips	½ ,, ,,	1s.	6d.
Snowdrops	½ ,, ,,	1s. 6d.	9d.
Hyacinths	½ ,, ,,	3s.	1s. 6d.
Stock	½ ,, ,,	3s.	1s. 6d.
Carnations (foreign) ..	3 ,, ,,	9d.	2s. 3d.
Carnations (English)	1 ,, ,,	3s.	3s.
Mimosa	1 ,, ,,	1s.	1s.
Asparagus	1 ,, ,,	6d.	6d.
Freezia	½ ,, ,,	3s.	1s. 6d.
Ferns (various) ..	2 ,, ,,	(aver.) 9d.	1s. 6d.
Ivy leaves	3 bunches	2d. per bunch	6d.
Berberis	2 ,,	3d. ,, ,,	6d.
		Total amount expended ..	£1 14s. 0d.

PLANTS IN POTS.

Plant.	Number of pots.	Cost.
Palms (large)	1 dozen	30s.
,, (small)	2 ,,	3s.
Ferns (large)	1 ,,	12s.
,, (small)	2 ,,	8s.
Tulips	½ ,,	3s.
Heaths	½ ,,	3s. 9d.
Solanum	½ ,,	4s.
Genista	½ ,,	4s.
Cyclamen	½ ,,	4s. 6d.
Miscellaneous	1 ,,	4s.
Total amount expended ..		£3 16s. 3d.

It will of course be understood that these prices represent fair average net prices at Covent Garden. All florists cannot buy at Covent Garden, and the prices of flowers vary with the season, so that the florist must exercise his judgment and regard these as merely exemplary of the range of an opening stock. Besides these flowers and plants, another £3 would be expended on wire frames (for wreaths, etc.), flower baskets and so forth. Buying must be done every second day at least, and as the business grows, attendance at the market every morning, or daily supplies sent to the shop, will be the rule.

Credit, Prices, and Business Promoters. In a business such as we have indicated the selling must be run for strict cash. The small capitalist cannot afford to give his customers credit, particularly in a new business, and when he has almost invariably to pay cash for his daily supplies. The stock of cut flowers must of necessity be turned over daily, as they are so perishable. This gives the beginner a certain amount of cash always in hand, and to cover loss from waste he must make a profit of 100 per cent. at least on cut flowers. That is to say, a bunch that cost him sixpence must be sold at not less than 1s. On plants a profit of from 25 per cent. to 50 per cent. on the turnover should suffice, as pot plants will keep. The best paying part of the business is, however, in the making of funereal wreaths, and care should be taken to develop this part of the business on every conceivable opportunity. Bouquets for weddings are also productive of much profit if tastefully and carefully made up, and in some neighbourhoods quite a large trade in "buttonholes" may be done. After paying all expenses an average profit of about 15 per cent. may be fairly looked for on the total sales. Many florists make the seed trade an important adjunct of their business, and provided the neighbourhood is a good-class suburban one with no large seedsman in the district, this traffic in seeds is not to be despised. Most suburban householders are proud of their gardens and their idiosyncrasies should be catered for. It is advisable (from a pecuniary point of view, if from no other) to pack seeds in one's own packets from seeds bought in bulk, for the put-up seeds bear a comparatively small profit. An advertisement running in the local paper is an aider and abettor of business to the beginner, and the bright shop with fresh stock always on view and attentive proprietor and assistants all combine to assure the success of the florist who begins even in a small way.

FRUITERERS

Within the past fifteen years the fruit trade in Great Britain has developed enormously. This is largely due to improved methods of cold storage, which has brought a plentiful supply, and, therefore, cheap fruit, within the reach of the million. The consequence of the demand has been naturally a rapid increase in the number of dealers in fruit. But the consumption of fruit is still growing, and to an energetic man or woman, with a more or less extensive knowledge of the trade, the retail business offers a fine field

for activity. It must not be forgotten that there is much annoying opposition to the regular shopkeeper in the fruit trade from costers. These pushful vendors of fruit are thorns in the flesh of the fruiterer in business with a shop rent to pay. For the coster makes a practice of attending the wholesale markets, such as Covent Garden, buying up at a cheap price what is left after the regular auctions are over, and selling cheaply in the streets from his barrow or stall, or going from door to door in suburban neighbourhoods and selling for what he can get. It is a form of competition which the regularly-established shopkeeper finds it very hard to compete against, and it is even more irritating than the opposition of the neighbouring grocer, who makes fresh and dried fruits one of his side lines.

Preliminaries. We will assume, however, that a young man, who has a fairly accurate knowledge of buying and selling fresh fruit, is not daunted by fear of costers or aught else, and has determined to start on his own account. First of all he must have saved or acquired a capital of £60 to £100, and competent fruiterers state that, especially for a young man, a wife is an absolute essential. The advantages of a working matrimonial partner, with an equal interest in the success of the young concern, are obvious. The neighbourhood selected for the new start would be either a prosperous suburb or a small open (windowless) shop in the busy streets of a large town. The rent required for a small single-window shop in a middle-class London suburb, for instance, would be £30 or £40, rates and taxes making it up to £50 to £60. The beginner will best judge for himself whether a window with or without glass is most suitable for his trade and his neighbourhood, but he should see that he has the right to at least a few feet of forecourt in front of his window or beside his door to display some of his goods direct to his customers without the intervention of glass. The fruit-buying public nowadays exhibit a liking for seeing the fruit at close quarters, and a good deal of fruit retailing is done on the pavement in front of the shop.

Shop Fittings. The fittings required are by no means either ornate or elaborate, and £15 to £20 will cover all requirements in that line. Some wooden shelving round the shop, a quantity of bins, a few baskets and boxes for display purposes in the window and on the shelves, are necessary. Trestles for outside display are often employed even where there is an actual glass window, and the bottom of the window should be sloped and neatly fitted with attractive baskets, trays, and boxes for displaying the goods. A few glass shelves suspended from the window ceiling for holding special lines may be used, and one or two sets of scales with brass pans are necessary. The price of a set of scales and weights to weigh up to 7 lb. would be not more than 15s. A few baskets for sending out orders may be required, but it is assumed that the business done will be at first for cash almost exclusively, and that, with a few exceptions, perhaps, the customers will carry away the goods for which they have paid. Paper bags with names and addresses printed on are of course necessary, but an expenditure of £1 in that direction will go a long way. Small baskets cost from about 1s. 3d. to 1s. 6d. each; while larger sizes cost 2s. to 3s. 6d. In suburban neighbourhoods weekly credit is often given to customers, and when this is decided upon, two or three dozen small pass-books (costing 4d. or 6d. each) are necessary to keep tally with the weekly creditors. A boy to take out orders and clean up generally is a necessity; he will cost anything from 5s. to 10s. a week.

Fruits in their Season. The stock of a fruiterer, pure and simple—as apart from a greengrocer—exhibits considerable variation. It would be idle to attempt to tell a man what to buy and when. That must be learned by experience, and no amount of writing will enable a man to gauge accurately what to stock for his particular neighbourhood and when to buy. Everything depends on the season of the year, the state of the fruit crop, and the demands of the neighbourhood. We have endeavoured in the table on next page to give an approximate indicaton of the principal fruits which a beginner such as we have described would stock, the country or port from whence the fruits come, the manner in which they are received in wholesale quantities, and the season of the year at which they arrive in this country or are "in season" for eating or cooking purposes. Besides the items mentioned there are a number of dried fruits, such as prunes, raisins, currants, etc., and nuts (hazel, Barcelonas, Brazils, walnuts, etc.), that may or may not be kept at first, but which would probably be added with the development of business.

Buying. A decision which has recently been arrived at by the members of the London and Provincial Fruit Buyers' Association may have some effect on the purchasing powers of small buyers in future. The large buyers complained that the small buyers could purchase small quantities at Covent Garden and at large provincial markets on the same terms as the largest buyers, and a schedule was adopted which substantially increased the minimum quantities to be permitted to be sold by first-hand brokers. But the beginner will find little difficulty in buying correctly, provided he keeps a keen eye on things and attends the market regularly every morning, or every second or third morning, as need be. To lay in an opening stock our London suburban fruiterer would therefore go to Covent Garden early one morning and make his selection. The season of the year primarily determines the fruits he would buy, but we will suppose that he begins in January. He would select one barrel (about 120 lb.) of apples, which would cost him 21s. These would retail at perhaps 3d. per lb., so he would require also a good dessert apple (Newtown Pippin or whatever his fancy might be) to sell at 5d. to 6d. per lb., and of these a case of 40 lb. would cost him about 16s. These cases are always the same size, but the sizes of the apples often vary.

THE SOURCES, PACKAGES, AND SEASONS OF FRUITS

Fruit.	Sources.	Packages.	Season.
Almonds (sweet)	Malaga (Jordan)	Bags of about 106 to 108 lb.	December to March
,, ,,	Barbary		September to March
,, ,,	Valencia		December to February
,, ,,	Sicily		,,
Apples	Australia	Barrels of about 120 lb. and boxes of 40 lb.	May to August
,,	Canada (Ontario)	Barrels of about 144 lb.	November to March
,,	Canada (Nova Scotia)	Barrels of about 120 lb.	,,
,,	California	Cases of about 50 lb.	November to February
,,	England	Baskets of 28 lb. and 56 lb.	August to November
Apricots	England	Boxes of 12 to 60	May (green), June, July
,,	France	,, 12 to 25 and cases of about 96	June to August
,,	Cape Colony	,, 24 to 36	,,
Bananas	Canary Isles	Bunches of various sizes, loose and in crates of 1 and 2 bunches	All the year round
,,	Ceylon		
,,	Jamaica		
Blackberries	England	Baskets of from 6lb. to 28 lb.	September
Cherries	England	Baskets of 12 lb. to 28 lb.	April (forced), May, June
,,	France	Boxes of 2lb. to 5 lb. and baskets of 9 lb., 10 lb., 18 lb. and 20 lb.	April to August
Chestnuts	England	Bags of 80 lb. and 120 lb.	November to January
,,	France		
,,	Italy		,,
Coconuts	Ceylon	Loose or in bags of 50 lb. to 100 lb.	June to November
,,	India		
,,	Africa		,,
,,	South America		
Currants (red and black)	England	Baskets of 5 lb., 12 lb. and 28 lb.	June to August
,, (black)	France	Baskets of 6 lb. to 8 lb. and 20 lb. to 24 lb.	June, July
Dates	Fez	Boxes of 80 lb.	October to February
,,	Tunis	Cases of 50 boxes of 1 lb. each	August to January
Figs	Smyrna	Boxes of 2 lb. to 5 lb.	,,
,,	Malaga		,,
,,	Valencia		January to October
Gooseberries	England	Baskets 6 lb. to 28 lb. and special varieties in 1 lb. punnets	May to August
,,	France	Baskets of 12 lb. to 15 lb.	May to August
Grapes	Cape Colony	Boxes of about 10 lb.	February and March
,,	Lisbon	Cases and barrels of 50 lb. to 55 lb.	August to November
,,	Malaga		
,,	Denia	Boxes of about 12 lb. and barrels of 26 lb.	August
,,	England	Baskets of 8 lb. or 10 lb.	
Lemons	Australia	Cases of 200 to 360	September and November
,,	Messina	Cases of 200, 300, and 360	November to August
,,	Naples		March to October
,,	Palermo		November to August
Melons	England	Baskets and boxes of 2 to 6, crates of 4 to 24, baskets of 12 to 18, cases of 24, 36, and 48	March to October
,,	France		,,
,,	Italy		,,
,,	Spain		,,
Nuts (Hazel)	England	Bags (about 128 lb.)	December to March
Oranges	Almeria	Cases. Finest qualities packed separately, wrapped in tissue paper in fancy boxes. Usually three sizes of cases containing 420, 714, and 1064 oranges respectively	November
,,	Australia		July to September
,,	Brazil		August and September
,,	Denia		November to July
,,	Florida		September and October
,,	Jaffa		October to February
,,	Messina		,,
,,	Malta		December to March
,,	Murcia		July and August
,,	Naples		May to August
,,	Palermo		October to February
,,	Seville		January to March
,,	Valencia		November to July
Peaches	England	Boxes of 12 to 36	June to September
,,	France	,, 12 to 15 and baskets of 14 lb.	July to December
,,	California	,, about 48	,,
Pears	England	Boxes (best packed in husks, each fruit in separate paper)	September to November
,,	Canada	Barrels of 160 lb.	,,
,,	California	Boxes of about 60 lb. to 80 lb.	,,
,,	South Africa	Cases of 20 to 50	
Pineapples	South America	Cases of 12	June to February
,,	West Indies	Cases of 6 to 12	,,
,,	Ceylon		,,
Plums	California	Cases of 28 lb to 30 lb.	September to March
,,	France	Baskets of about 20 lb.	,,
,,	England	,, 12 lb. to 28 lb.	,,
Raspberries	England	Baskets of 1 lb. to 12 lb.	June to August
Rhubarb	England	Bundles (loose)	April to July
Strawberries	England and Scotland	Punnets of 1 lb. to 12 lb.	May to July
,,	France	Baskets of 5 lb.	,,
Tomatoes	England and Scotland	Baskets of 6 lb. to 12 lb.	All the year round (under glass)
,,	Channel Isles	,, 12 lb.	June to August
,,	Canary Isles	Boxes of 12 lb. to 16 lb.	December to February
,,	Valencia	,, 7 lb. to 9 lb.	July
,,	Lisbon	Cases of about 40 lb.	August
,,	France	Crates of 24 lb.	

Then a bushel (40 to 43 lb.) of English cooking apples (Wellingtons, etc.) to sell at 4d. per lb. would absorb another 11s. Passing on to the orange section he would buy one case (containing 714 oranges) to retail at 6d. per dozen, and another case (of 420) to retail at 9d. per dozen; the larger case costing 15s., and the smaller 12s. to 12s. 6d. Then half a dozen boxes of Tangerines (costing 3s. to 4s.) might be secured to retail at 6d. per dozen. Bananas are nowadays an important item. He would select a "stalk" costing 8s. or 9s. Such a stalk would have in it anything from 12 to 17 dozen bananas, and the retail price would be 1s. per dozen. A 36 lb. barrel of green Almerian grapes (selling price 4d. to 6d. per lb.) would cost 10s., while a basket (8 to 10 lb.) of good black grapes (English or other) would run to 1s. 6d. per lb.—the usual retail price being 2s. Stewing pears would be required at this season, and would be priced at about 2s. per dozen—retail 4d. per lb. Lemons might be bought at 3s. per 100 and retailed at 1d. each. Twenty-four pounds of tomatoes, English and foreign, would mean another half-sovereign, at least, and small quantities of dates, figs, pineapples would pretty well exhaust the seasonable staples. But there are things like chestnuts, Barcelona nuts, Brazils, walnuts, and so forth, that the experienced man would find it necessary to order, and £2 or £3 worth of these would go a long way. Care and experience are necessary in selecting the fruits bought, for the proper bloom of the grape, the requisite ripeness of the banana or tomato, and the over-ripeness or otherwise of an orange are things to be learned, if possible, before the start.

Turn-over and Profit. The foregoing approximate estimate applies, of course, only to January trade. Fruit dealing is, perhaps, more a "season" trade than any other, and so much in the way of profit depends upon the weather and the scarcity or plentifulness of the fruits that no definite guide can be given. As the season goes on, blackberries, raspberries, currants, strawberries, apples, pears, and other English fruits have to be stocked, and it must never be forgotten that fruits are the most perishable of goods. A man must turn over his stock at the very least two or three times a week, and experienced fruiterers declare that, even with careful management, the waste may be put down in such a business as we are considering at £1 a week. This has to be taken cognisance of in the selling, but the quick turnover has its advantages in the fact that a man has always money in hand to carry on the business. The average profits on the return may be put at from 35 to 40 per cent.—below which the business is a perpetual struggle.

Fruit-growing at Home and Abroad. In this country, as everyone in the trade knows, British-grown fruit is preferred. The development of the fruit industry in Great Britain has been considerable in recent years. British grape-growing is extending annually, the principal districts being round Worthing, Swanley, Finchley, Uxbridge, Tottenham, Whetstone, and some places in Scotland and Wales. Plums are grown in Worcestershire, Cambridgeshire, Kent, Essex, Bedfordshire, Cheshire, Buckinghamshire, Norfolk, Gloucestershire, and Herefordshire, while there are well-recognised districts for cherries, gooseberries, raspberries, strawberries, currants, tomatoes, apples, pears, etc., in England and Scotland. There are important fruit markets in Liverpool, Manchester, Birmingham, Hull, Newcastle-on-Tyne, Glasgow, Edinburgh, Bristol, Cardiff, Cork, Belfast, and Dublin.

Colonial Fruit. It is probable, also, that many of the British Colonies in the Southern Hemisphere will attain an increasing importance as sources of both fruits and vegetables for the British market. Their particular sphere will be to give us many fresh fruits and vegetables when the season for our supplies of these grown in the Northern Hemisphere is past. Efforts are being put forth by many Colonial Governments to ensure that exported fruits shall be carefully selected and packed, so that a reputation for quality may be achieved. South Africa sends us now fairly large quantities of grapes, plums, pears, and peaches, and shipments have been made of apricots, nectarines, apples, and quinces. Some of the consignments have been experimental only, and the nature of the fruit trade prevents phenomenal development, such as is possible in manufactured products. Thus, its growth will be gradual.

The South African grape, known as the "Hanepoote," is a large berry of a sweet flavour, which ranks with our European "Muscatel." South African apples which have reached London are similar to the Californian "Newtown Pippin," and when the quantity rises to market demands will prolong the fresh apple season till the end of January. High hopes are not entertained of seed fruits, such as quinces, on account of public prejudice, engendered in some degree by fears of appendicitis. The pineapples of South Africa ought to prove popular in Great Britain. They are small, and may be sold as low as 6d. each, thereby making this delicious fruit the dainty of the man or woman with a small purse. The principal fruit product of Jamaica is the banana, but not more than a million bunches come to this country. The prices locally are 6d. to 2s. a bunch; in London, 3s. to 9s. Jamaica also exports from 80,000,000 to 100,000,000 oranges yearly, of which most go to the United States and Canada. The Jamaica orange deserves greater popularity than it has yet attained here; the price is 9s. to 15s. a case. Pineapples grow abundantly in Jamaica, but the growers have not succeeded in making profitable shipments to England. There is an unlimited supply of mangoes, for which the market in England is at present very restricted. They are sold here at 4s. to 6s. a dozen; locally, at a farthing each or less.

Continued

HEARING, TASTE, SMELL, SPEECH

Group 25
PHYSIOLOGY
18

Continued from page 2403

Structure of the Ear. Its Delicate Mechanism. Functions of the Tongue, the Nose and the Larynx. Care of the Voice. Articulation

By Dr. A. T SCHOFIELD

HEARING

All are acquainted with the appearance and shape of the external organ which we call the ear, but few know anything of the complicated structure. We may, in a sense, be said to have six ears, three on each side; for each organ is divided into *outer*, *middle*, and *inner* ear.

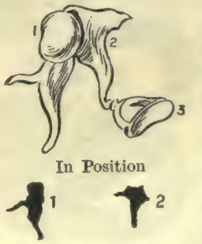
The Outer Ear. The outer ear consists of the *pinna*, or ear proper, and the auditory canal leading to the middle ear. In man it is of far less use as an organ of hearing than in the lower animals, partly from the feeble power we have of moving it. There are, indeed, three muscles for the purpose, but they are so weak and so little under the control of the will, as to be of little use. The outer ear is, however, an ornament when well shaped, and collects some of the waves of sound [**134**].

An ingenious observer states that the edge of the pinna vibrates to a perfect octave, as can be proved by drawing a small bow across it. The small knob at the upper and back part corresponds to the tip of the ear in animals, and in some men is almost a point.

134. DIAGRAM OF EAR
1. Pinna 2. Passage to (3.) Drum 4. Middle ear 5. Air tube to throat 6. Inner ear 7. Semicircular canals 8. Nerve of hearing

The Direction of Sound. The hearing of the ear can be improved and more sound waves collected by placing the hand behind the ear so as to enlarge it. Perhaps the chief use of the outer ear, as its general inclination is forward, is to indicate the direction from which the sound proceeds, as this is loudest when the ear is at right angles to it. The knowledge of sound direction is, however, very imperfect in many, for if a person be blindfolded, it is almost impossible for him to indicate whence any sound proceeds. In almost every detail of the sense of hearing, we are very deficient compared with other animals.

The Auditory Canal. The pinna leads into the *auditory canal*, an inch long, lined with stiff hairs and a bitter wax, to prevent the intrusion of unwelcome insects, and bounded at the end by the drumhead, or *tympanum*, stretched across it at an angle of about forty-five degrees. This membrane is the thickness of a piece of foreign note-paper, which will explain how easily it is injured by a hairpin or pencil. It will also be understood that all ear-drops are completely useless for any disease that lies behind this membrane, beyond which they cannot penetrate. It is unevenly stretched so as to take up vibrations of air from 30 a second up to 4,000. The head of a drum is evenly stretched and can only take up one set of air waves.



135 THE EAR BONES
1. Hammer 2. Anvil 3. Stirrup

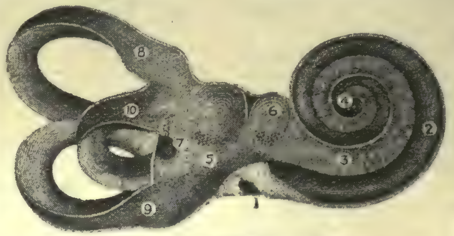
The Middle Ear. Passing behind to the middle ear, we find it is half an inch high and one-eighth of an inch broad, something the shape of a button on its end. It is lined everywhere with ciliated (wavy) epithelium and is in direct communication with the air by the *Eustachian tube*, two inches long, opening into the throat. Air is thus freely admitted in health to both sides of the ear-drum, and in consequence it can vibrate freely. The failure of this through the stopping up of the Eustachian tube is a great and common cause of deafness. By holding the breath, and then swallowing, air can be forced up the Eustachian tube, causing a pressure that can be felt in these middle ears.

The outer wall of this chamber is, of course, formed by the *drum*; while in the inner wall opposite are seen *two smaller drums* stretched across two openings, the one being oval (Latin, *Fenestra ovalis*), and the other round (Latin, *Fenestra rotunda*).

Its Bones and Muscles. The *ciliated epithelium* always waves in the direction of the throat, so as to hinder impurities from collecting in this chamber. Stretched across the ear from the tympanum to the oval inner drum is a curious chain of three bones. They are called respectively, from their suggestive shapes, the *hammer*, the *anvil*, and the *stirrup-bone* [**135**]. The hammer (Latin, *malleus*), slung from the roof has its handle tightly bound down to the

136. ARTICULATION OF THE EAR BONES
1. Articulates with anvil 2. Lies against drum 3. Articulates with hammer 4. Articulates with head of stirrup 5. Articulates with anvil 6. Articulates with the oval drum of inner ear

inner side of the tympanum, while the head rests on the head of the next bone, the anvil (Latin, *incus*) [136]. This, also slung from the roof, is articulated by one of its feet with the head of a well-shaped bony stirrup (Latin, *stapedius*), which in its turn has its base or foot-plate attached to the oval membrane on the internal wall. The purpose, if not the peculiar shapes, of these bones is sufficiently obvious. It is well known that all sounds are caused by vibrations, or waves, of air; these waves are collected by the outer ear, pass up the auditory canal, and, striking on the tympanum, cause it to vibrate. The vibrations move the air in the middle ear in a similar way, causing vibrations that strike on the membranes of the inner wall, so that some hearing is possible without the ossicles at all. The excessive accuracy necessary, however, to secure the hearing of speech is secured by this apparatus, every vibration being carried with absolute exactitude from the handle of the hammer, fixed against the tympanum by the plate of the stirrup, to the inner membrane; the speed of the vibrations is from 16 for the lowest note to 40,000 per second for the highest. Two muscles, one the smallest in the body, regulate these vibrations by tightening the drums. One of the two little muscles can both tighten the drum to a further pitch of acuteness in listening intently, or slacken it considerably if any loud sound is expected that might rupture it. The outer muscle is fixed in the same way to the stirrup to regulate the inner membrane.



137. THE INTERNAL EAR
1. Fenestra rotunda 2. Scala tympani 3. Scala vestibuli 4. Cupola 5. Vestibule 6. Saccule 7. Aqueductus vestibuli 8. Superior semicircular canal 9. Horizontal semicircular canal 10. Posterior semicircular canal

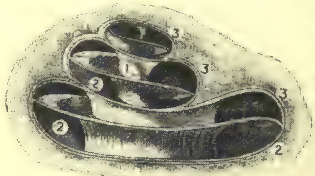
The Inner Ear. In now proceeding to describe the internal ear [137], or real organ of hearing, the very simplest explanation will be given, but at the same time the details are so complicated as to need close attention, and yet they are too interesting and important to be omitted.

Behind the oval drum or fenestra ovalis, to which the foot of the stirrup is fixed, is a small bony chamber called the *vestibule*, filled with fluid and containing a membranous bag, also filled with fluid. This bag contains some of the naked axis cylinder endings of the *auditory nerve* terminating in tiny bead-like heads, and in the bag are also a number of *sharp crystals*, which, being violently moved about during vibrations transmitted from the oval drum, probably strike these nerve ends with varying force.

Where Sounds are Interpreted. In the vestibule by means of these crystals the intensity and distance of the sound is judged before the waves pass on to the true inner ear to be interpreted into notes or speech. The differing intensity with which these particles strike the naked nerves is supposed to tell whether the voice or music is loud or soft, whether near or distant, whether advancing or receding, and so on. This vestibule also contains five openings leading to the *three semicircular canals* (two of them having a common opening), which are very curious structures, made of bone and all opening into the vestibule, the first being *vertical* to the position of the body, the second *horizontal*, and the third *transverse*, so as to lie in the three directions of solidity—length, breadth and depth.

Human Spirit-levels. The canals are also lined with membranes filled with fluid, and are supposed to act like spirit-levels; they are connected with the cerebellum, or organ of equilibrium so that it is informed at once in which canal the greatest pressure exists, according to the varying positions of the head, and can automatically restore the balance by muscular action. It has been found that in certain diseases when one of these canals has been injured, the body has the tendency to roll over in a similar direction, either forward, or sideways, or backwards. The canals are also supposed to determine the position of the sound we hear, and the close connection they form between sound and equilibrium shows the value of a band to soldiers when marching.

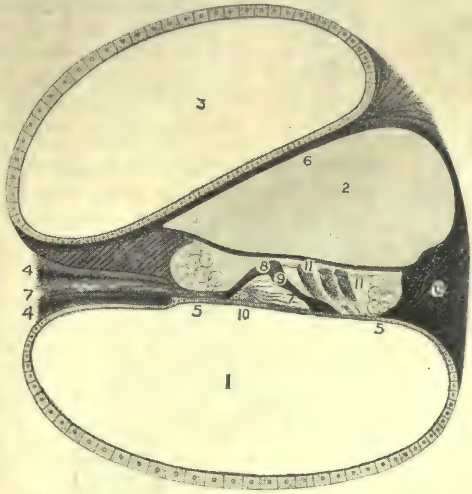
Delicate Mechanism. Leaning against the internal wall of the vestibule and also against the round drum of the middle ear, is the broad end of what looks like a small periwinkle shell, *the cochlea* [138], which, instead of having one spiral canal, has two, the one (the *scala vestibuli*) opening into the vestibule, the other (the *scala tympani*) ending at the round opening in the middle ear. This double canal consists of two and a half turns, getting, of course, smaller towards the top, where the two communicate by a minute hole. Both are entirely filled with a limpid saltish fluid. This double spiral is separated by a fine membrane (the *basilar membrane*). The upper spiral of *scala vestibuli* is subdivided again by the *membrane of Reissner*, and the lower space is called the *scala media*. In this scala media, is the *organ of Corti*, or the real apparatus for hearing. Resting on the inner and upper surface of the basilar membrane, and continuing round and round to the top, are a continuous row of *little headed rods*, like pianoforte hammers, all graduated in size, getting smaller and smaller as they ascend, about 6,000 in number [139]. On the outer side of the



138. SECTION OF COCHLEA
1. Modiolus 2. Scala tympani 3. Scala vestibuli

membrane are arranged a corresponding number of *hollow pads*, into two of which three of these little hammers accurately fit, there being therefore about 4,500 of them, and it must clearly be remembered that every hammer and every pad is a living cell. These hammers and pads form a tiny spiral arch, decreasing in size all the way up. There are also two or three rows of stiff bristle-like cells along this canal, passing through holes like eyelet-holes in the membrane above, in which they can freely vibrate.

How Sound is Transmitted. All this is supposed to be an arrangement for receiving and interpreting in some way the vibrations in the fluid around received from the air waves of sound by the two drums of the outer and middle ears, and transmitting them through the two divisions of the scala vestibuli up to the top of the spiral, whence they return down the scala tympani to the round drum. There are three theories as to how sound is transmitted as vibrations to the auditory nerve. It is supposed that each hammer vibrates to a definite length of vibration, and thus interprets the sound. A second theory is that it is the stiff bristle nerves that are thus tuned to take up the vibrations; but attention has lately been drawn to the structure of the basilar membrane itself, on which these both rest, and which is believed to consist of an infinite number of strings of different lengths, stretched side by side all the way up, and able, like violin strings, to respond to different vibrations; and the third theory is that this membrane is the true organ of hearing, the hammers, etc., resting on it serving merely to "stop" or deaden the strings. It is still a moot point as to whether the hammers, bristles, or membrane are the true organ of hearing. All three, however, are directly connected with the auditory nerves that run up the central pillar round which the spirals turn and transmit all vibrations to the auditory centre in the brain.



139. THE ORGAN OF HEARING IN THE COCHLEA
1. Scala tympani 2. Scala vestibuli 3. Canal of the cochlea 4. Lamina spiralis ossea 5. Membrana basilaris 6. Membrane of Reissner 7. Cochlear nerve 8. Inner rod of Corti 9. Outer rod of Corti 10. Inner hair cells 11. Outer hair cells 12. Ligamentum spirale

Sound Waves Heard and not Heard. The waves of sounds are waves in the air, very like waves at sea, varying from the lowest note we can hear, which are waves 64ft. long, and 16 to the second, to the highest, which are waves one-third of an inch long and 38,000 to the second, each octave higher having waves twice as fast and half as long as the fundamental note. There are plenty of sounds too shrill for our ears to receive—the squeal of a bat, the chirp of a cricket, are thus often unheard by us. By the aid of a Galton's whistle, notes can be produced too shrill for the human ear, though they can be easily heard by a horse or a dog.

Value of Two Ears. Just as in the eye, if the centre of hearing in the brain be injured all the elaborate apparatus we have described is useless. The ear has been compared to a telephone, as both depend entirely in the same way on vibrations. The value of two ears is that we can hear two things at the same time, as a clock striking and a conversation. We can also receive sounds equally well from either side of the head.

There is a distinct difference between *hearing* and *listening*, just as there is in the eye between *seeing* and *looking*. When we listen the brain centre is on the qui-vive, and all the apparatus is braced up to receive sounds, perhaps otherwise unnoticed, though not unheard.

Noises and Notes. The difference between a noise and a musical sound or note is that in the latter the waves are regular and of uniform length; in the former they are a mixture of different lengths.

From this brief description of hearing, it will be noted that the sound waves are transmitted by three media—solids, liquids, and gases. In the outer ear the waves are conducted partly by the air and partly by the cartilages of the ear and the bones of the head. The chain of bones transmits them to the inner ear, whence every vibration is taken up finally by fluid which, striking in various ways on the bare terminations of the auditory nerve, cause the perception of sound in the brain.

TASTE

Pimples on the Tongue. The tongue, the organ of taste, is covered with three varieties of papillæ or pimples. The first, called *filiform papillæ* [140], are thread-like elevations that abound over the middle of the tongue. They are sharp, whitish, and pointed. In a cat they are very hard, like small thorns or spines, while in the lion or tiger they are of terrible size, like rows of teeth, and capable of stripping the flesh off a bone with a single lick of the tongue. They are principally used in man for rasping the food against the furrowed roof of the hard palate.

The second class of pimples on the tongue, called *fungiform papillæ* [141], are mushroom-like elevations; these are scattered all over the tongue, and especially towards the front. They are round and very red, the skin over

them being very thin. They contain touch corpuscles, and are really a delicate part of the great sense of touch. They can at once discern the quality of what is in the mouth and if it be too hot or cold.

The third class of pimples are much larger and form a striking object at the back of the tongue. These are the *circumvallate papillæ* [**142**], or the "circular trench" pimples. They owe their peculiar name to their extraordinary shape. They are arranged—ten or twelve in number—right across the back of the tongue in the form of a V, with the point backwards, so as to catch all the food as it passes into the pharynx before it is swallowed. Each one consists of a flattened elevation with a slight central depression, and is surrounded by a depression like a trench (hence the name), and beyond the ditch is a slight circular elevation like a wall. Opening into the bottom of this trench are the numerous orifices of the glands which secrete a very powerful juice of great solvent power; while all along the sides, embedded in the walls, are bodies like oranges, called *taste buds*. From the top of each of these oval bodies, projecting into the trench, is a circular row of stiff hairs, making the whole rather like the head of a thistle. Part of all the food that is eaten falls into the trenches of these papillæ and part is dissolved; and then it is supposed that the ultimate particles strike against the hairs, which are really naked "nerve endings," but look like the feelers of sea anemones, the process being similar to that in the sacculus in the ear, where the crystals strike the nerve endings. The vibrations are conveyed to the taste buds and thence by nerves to the taste centre in the brain.

140. FILIFORM PAPILLÆ
(For rasping)
1. Artery **2.** Vein

How we Taste. In speaking of all these organs of special sense—whether of touch, taste, smell, hearing, or sight—it must be remembered that the special apparatus we described is only an arrangement for accurately transmitting the peculiar vibrations or sensations to the brain which alone feels, tastes, smells, hears, or sees; for, as has been shown, if certain districts of the brain are diseased, however perfect these apparatuses may be, nothing is perceived. Consider for one moment the marvels of a "special sense." The salt-cellar, for instance, has been filled up in mistake with sifted sugar, and you put some on the side of your plate and proceed to eat it with your beef. You believe it is salt, it looks like salt, and you use it as such, and you expect to discern its taste on the meat in the mouth. Some minute portions dissolved in the trench strike against the projecting nerve ends, and in some inscrutable way send up vibrations to the brain quite different from salt; and so forcible and strong is the effect in the taste centre that, against your belief and the endeavour of the senses, you declare it is sugar.

142. CIRCUMVALLATE PAPILLA
(For tasting)
1. Artery **2.** Vein **3.** Nerve
4. Water gland **5.** Muscle **6.** Taste buds at sides of trench

SMELL

The sense of smell really resides in the upper part of the nose, and here the olfactory or smelling nerves are situated. They project downwards in innumerable fine hair-like endings into the upper part of the nostrils, and are connected above with two large bulbs of brain matter in the under surface of the cortex of each hemisphere.

All parts of the nose can *feel* acutely; but if we wish to *smell* anything, we sniff up the odour into the upper part of the *nares*, or nostrils [**143**].

How we Smell. *Odours* are either suspended in exceedingly fine particles in the air or in gases so thin and imperceptible that it is only by the sense of smell they are discovered. The odour must be dissolved in the secretions of the nose before it can be smelled. Hence, with both taste and smell, if the article be absolutely insoluble, it cannot be discerned. If the nose be dry, as in fever, the sense of smell is lost; or, if there be too much secretion, as in a heavy cold, it is much impaired. The use of the sense of smell is a good deal under our own control, for it requires an effort of the will to hold the breath and take a deliberate sniff. This sense is far less keen in us than in animals.

141. FUNGIFORM PAPILLA
(For touching)
1. Artery **2.** Vein **3.** Nerve

Flavours. Some smells, such as those of pepper, ammonia, and acids, can hardly be distinguished from common sensation; and others closely connected with tastes we call flavours. The delicacy of the olfactory sense is most remarkable, for the most minute traces (one thirty-millionth of a gramme of musk), quite impossible to discern by any other means, can be smelled.

Pleasant and unpleasant odours are merely questions of judgment, just like colours and sounds; and what constitutes the sensation of pain or pleasure to which they give rise, is not fully understood.

SPEECH

Turning now to the important faculty of speech, we will try, very briefly, to describe, first the mechanical apparatus of the voice, then the production of air-currents, and the vocalisation and the articulation that produce speech, giving also a few hints on the use and management of the voice.

Three Stages. The whole process culminating in speech may be clearly divided into three parts. First, the production of the needed current and volume of air; next, the production of sound; and, thirdly, the moulding of this sound into words. For the first the lungs

are needed, for the second the larynx, and for the third the mouth—*i.e.*, the tongue, teeth, and lips.

The two former may be roughly compared to the common harmonium, where sound is produced by the wind being forced up from the air-chest below through the vibrating reeds above. There is, however, in the harmonium no further apparatus to form these sounds into words, and thus to correspond to the mouth. Moreover, for all the notes of the different octaves (say, three, which is the average compass of the human voice), no fewer than 36 separate reeds are needed; whereas, for the same compass in the human organ but one set of reeds is used, as there is a mechanism to alter it to all the different tones required. We know that the lungs are contained in the thorax or chest; the larynx, or voice-box, in the neck, a prominent part of it indeed, just where the vocal cords are affixed, being called the Adam's apple.

Construction of the Larynx. The larynx, or voice-box, is situated, as we have said, in the neck, and leads from the back of the mouth to the top of the trachea, which brings the air from the two lungs below. It is an open tube with a lid, and is about 3 in. long. The walls and lid are composed of cartilages. The largest is that forming the centre part of the tube, the *thyroid*, and is the least movable; the *epiglottis*, or lid, and other cartilages, to which are attached numerous muscles, being freely movable in various directions.

Across the middle of the tube, from the front to the back, are stretched two flat bands, fixed together at the front, but capable of being separated behind, where they are attached to two movable cartilages called *arytenoid*. When these two bands are brought together, they form a sort of flat drumhead or septum that shuts off the upper from the lower half of the larynx so perfectly that even a drop of water cannot pass through; while, on the other hand, they can be separated so widely that the opening is triangular, or, rather, the shape of a spearhead, the point being forward and the broad part backward. These bands are the true vocal cords, and the air that passes through the narrow chink between them is thrown into ripples or air waves by the vibration of their edges, and these waves, when they strike on the ear, produce sound. The two vocal cords in the larynx, therefore, by their vibration, are the true voice or sound-producers in the higher animals.

143. RIGHT NASAL FOSSA

1. Upper meatus 2. Middle meatus 3. Lower meatus 4. Opening into the Antrum of Highmore 5. Frontal lobe of the brain 6. Corpus callosum of brain 7. Olfactory bulb 8. Ramifications of the branches of the olfactory nerve in the nasal mucous membrane 9. Frontal sinus 10. Ethmoidal cells

The Vocal Cords. These are composed of elastic, muscular, and fibrous tissue, and are of a glistening white appearance, as may be clearly seen by a small mirror placed at an angle in the mouth, and called the laryngoscope [**144**].

Above them, on either side, the walls of the larynx make a sort of pouch, the upper parts of which, bulging into the larynx, form two folds above the true vocal cords, and, as they slightly resemble them, are called the false vocal cords. They act, to a certain extent, as dampers or deadeners of sound, though they never actually touch the cords; while the pouch between secretes a considerable amount of glairy fluid which serves to lubricate the cords and keep them from getting dry.

Action of the Tongue. At the top the lid, or epiglottis, of the larynx, which is hinged in front and folds down backwards over its mouth, is fixed to the under side of the back of the tongue in such a way that whenever the tongue is carried forward it is raised and opened, and when the tongue is carried back, as with food, it shuts tightly down, allowing all food and drink to pass over it and down the gullet behind. It closes over the larynx so completely that not a drop of water can pass down into the windpipe. In breathing, as well as in speaking or singing, it is, of course, always open, while in swallowing it is tightly shut. We cannot, therefore, breathe while we swallow, nor swallow while we breathe. Such then, briefly, is the construction of the larynx. It only remains for us to add that the whole larynx, as well as the windpipe, lung tubes, and back of the throat, are lined with ciliated epithelium in such a way as to pass up into the mouth any particles that may settle upon them. In nearly all affections of the air passage this membrane is more or less destroyed for the time being.

Voice Production. The voice is produced by the rushing of the air through the narrow chink between the bands or "cords," which can be plainly seen by anyone who can use the laryngoscope; on the other hand, these bands can be seen widely open and far apart during quiet respiration [**145**].

The narrower the chink the greater the pressure of the air as it passes through and the higher the note produced. By the varying tension and approximation of these cords a range of sound extending on an average to three octaves can be formed.

In the adult male the cords are nearly one-third longer than in the adult female.

An imitation of the voice apparatus can be

made by stretching across the top of a glass tube two bands of indiarubber close together. If these are blown through with a certain force, a sound will be emitted, higher or lower, according to the tension.

The action of the cords as well as the closure of the top of the larynx being regulated unconsciously, it would appear at first sight that we cannot do much voluntarily in arranging the production of the voice. Such, however, is far from being the case. We can, in the first place, see that the delicate structures are not in any way injured by our carelessness; and, secondly, we can, by practice, regulate to an exact nicety the action of the cords so as to produce instantaneously the exact sound required.

Breathing through the Nose. A great point in the care of the larynx is to breathe through the nose, and not through the mouth. The mouth is made for expiration, specially in speech and vocalisation, but not for inspiration, for which the nose is specially constructed. The mouth should be kept shut, but it is still possible to breathe through the nose with the mouth wide open when once the habit is acquired; and, on the other hand, there are certain passages in singing where, owing to the elevation of the soft palate, breathing through the mouth is necessary. If the nose cannot be or is not regularly used as "the" respiratory passage, a doctor should be consulted at once, as there is something blocking the natural passage—enlarged tonsils, adenoid growths, or some malformation.

Care of the Voice. Sudden changes of temperature are extremely injurious to the vocal cords, especially after prolonged use. Great care should be taken by speakers and singers against chills or draughts of cold air after using the voice, and also after leaving close or heated rooms. A loose muffler over the mouth and nose when first going out is a wise precaution. Air too dry or too damp is also injurious in public speaking. Air, again, overladen with dust or smoke or fog is most injurious to the vocal organs, which must suffer, if the voice be much used under such circumstances.

No loud speaking or singing should be persevered in if the throat be at all sore or relaxed, or if there be a severe cold in the head. Neglect of this is one of the common causes of clergyman's sore throat. Of course, as we have already said, any definite chest affection, such as bronchitis, precludes all public speaking.

Management of Expiration. So far, we have spoken of inspiration in connection with the larynx; let us now consider, for a moment, expiration.

We have already said this is to be carefully economised and none of the air wasted. The exit of the air can be retarded by the approximation of the vocal cords. But this, of course, raises the pitch of the voice or note. The secret of keeping at the same note and yet retarding the exit of the air is by the approximation of the false vocal cords above the true. This can only be done, as we say, instinctively, or, rather, unconsciously, by practice; and the retardation of the expiration, so as only to use what air is needed and keep some well in hand, is one of the secrets of ease in speaking and singing.

There should be no strain in singing or speech. Loudness is not necessary for force or beauty, but a good volume of air is.

Pitch. The pitch in speaking is of great importance, not only to the speaker but to the hearers. With regard to the latter, it is not too much to say that the conveyance of thought by speech depends not only on the words, but the tone and pitch. It is wonderful what a power to sway thought a well-pitched and modulated voice possesses. Of course, in singing, the pitch is always considered; but in speaking this is rarely done, though its importance to the speaker is as great as to his audience. A wrong pitch strains the voice and the vocal cords. We all have for speaking what may be termed a natural pitch of voice, just as we have a natural pace for walking, and that is the pace or pitch which we can use with the greatest ease and without strain.

144. SUPERIOR APERTURE OF LARYNX

Showing the glottis during emission of a high note

1. Root of tongue **2.** Epiglottis **3.** Posterior wall of pharynx **4.** Rima glottidis **5.** True vocal cords **6.** False vocal cords

Public Speaking. There can be no doubt that absolute ignorance of the simple laws of voice production still prevails even amongst our most constant speakers, and it is not much to the credit of the twentieth century that amongst large bodies of men such as clergy, barristers, etc., whose living depends very largely on their voice, many should fall out of the ranks altogether, or, at any rate, suffer needless pain and misery for want of a few lessons on this most useful art. At Athens every student was taught how to speak properly and to use the voice with ease and effect, as being essential to health, quite apart from its special value to speakers.

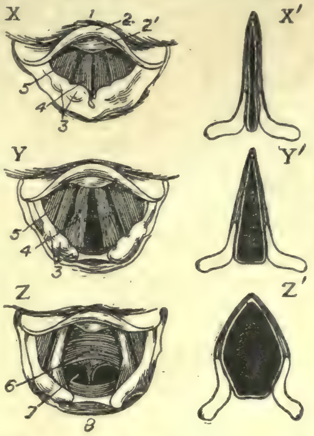
We have little doubt that for a child of a consumptive tendency there could not be a more healthful and curative—or, rather preventive—exercise than a thorough course of instruction in voice production by a competent teacher. At any rate, it is beyond dispute that such a course should form an integral part of the education of every public speaker. This is especially the case with the clergy. They are the class whose vocal organs are most severely tried. The buildings in which they speak are often far more trying than concert-halls or lecture-rooms, which are built to carry sound. The vaulted roof, the long aisles, the cold, vault-like air at the early morning service, the close stuffiness of the crowded evening church, the incurable and ever

present draughts, are all bad. Worse still is the "pulpit voice," artificial and strained; it is bad for the larynx and throat, and wears them out, while a natural voice would continue in full vigour and tone.

Articulation. Passing on now to the third part of speech production, that of articulation in the throat and mouth, we may point out that it consists of at least two processes. First, the moulding or shaping of the air-vessel into the various vowel sounds by the opening and closing of the throat, "ah" being sounded when the throat is open to its widest, and "oo" when it is most nearly closed, the other sounds falling in between. Secondly, the cutting off of these sound waves into different lengths, to form words or syllables, by means of what are called consonants, which are closures and sudden openings that first stop and then allow of the passage of air and of the vowel sound by the closure of the lips as in "m," or with the tongue against the front of the hard palate and teeth as in "s," or against the front of the hard palate as in "t," only the opening of the fauces as in "k" or "g," and so on—each consonant giving a characteristic "click" or other sound of opening.

Vowels alone are true vocal sounds that can be prolonged as long as the mouth remains in the same shape, and as long as the current of air continues, the pitch being, of course, determined by the vocal cords.

It is all important to enunciate and articulate clearly; all the vowel and consonant sounds should, therefore, be carefully practised with the greatest accuracy; such practice, like all other vocal exercises, is best done before a mirror.



145. THE LARYNX AND GLOTTIS

X and **X′**. Nearly closed for highest notes **Y** and **Y′**. Open for quiet breathing **Z** and **Z′**. Open very wide for gaping **1.** Base of tongue **2.** Tip of epiglottis **2′.** Thyroid cartilage **3.** Triangular cartilage to which vocal cords (**4.**) are fixed **5.** False vocal cords **6.** Inside of larynx **7.** Wind pipe **8.** Point of gullet

The Aspirate. The letter "h" is often an insuperable difficulty. It is, perhaps, best overcome by expiring forcibly against a window-pane and adding some syllable such as "at" or "ot" to the expiration. The expiration is then gradually shortened till it becomes "hat" or "hot."

Another difficulty is stammering or stuttering. In minor cases this is cured by slow, deliberate formation of each word until the habit is broken. More severe cases require special treatment, which is now admirably conducted. Nearly all are curable. "Take care of the consonants, and the vowels will take care of themselves."

For proper speech the teeth should be complete in number and kept in good order. If the tongue is swollen or sore, or the tonsils enlarged, speech is difficult. In the latter case, enlargement of the tonsils, the removal of the same portion under surgical advice is of great value. The throat also must be in good order.

Effect of Food and Drink. Food and drink greatly affect the condition of the lining membrane, both of the mouth and throat, and indirectly of the vocal cords. First and foremost is the abuse of alcohol. No one who speaks or sings much can indulge freely in alcohol with impunity, while in many even a small quantity is prejudicial, as the effect on the stomach and pharynx is distinctly bad. The very voice of the habitual drunkard speaks of the ravages caused by alcohol. In small doses, well diluted and taken with food, alcohol is not itself harmful to the voice organs when they are in health, but if they are diseased even a very small quantity may do harm. Strong tobacco, especially in the form of cigarettes, is injurious to the voice.

Much hot tea, in the same way acting on the digestion, is not beneficial to the voice; coffee or cocoa, or cold tea, especially if not too strong, are not harmful. It is not well to use the voice publicly at any length sooner than two hours after a full meal.

Two great practical defects in speaking and singing may be noticed. One is that the mouth is often not sufficiently opened, and the other is that the voice is often dropped two or three or more tones in pitch towards the end of a sentence so that the words are quite lost at a little distance.

The secret of easy public speaking is the understanding of respiration so as to retard it at will, the use of the right pitch, modulated tone, and the natural voice, avoiding a forced or artificial voice, monotones, and all strain. Speak in an erect position, eat suitable food, and retain as far as possible good general health and sound nerves.

The "British Medical Journal" enumerates four special points on the right use of the voice:

1. Thorough control of the motive power of the voice and breath.
2. A proper attack of tone.
3. The education of the resonant cavities of speech.
4. The right pitch.

With this consideration of the organs of the senses we reach the conclusion of our survey of the human being from the physiological point of view; and we shall now turn to a subject of vital concern in all our lives—the prevention of disease and the maintenance of the body in health.

Physiology concluded

MACHINE MOULDING

The Processes and Appliances of Machine Moulding. Examples of Moulding Machines and their Advantages. Wheel Moulding

By JOSEPH G. HORNER

THE highest development of moulding, that by machine, is one that grows very rapidly. It is divisible under two groups—one devoted to general work, the other specially to toothed wheels, the latter constituting a very much smaller group than the former.

Types of Moulding Machines. In reference to the first, there are some dozens of distinct types of moulding machines now made, and operated either by hand, as in **98** and **99**, steam, water, or compressed air. Patterns may be rammed by the machine, or by hand, but they are always withdrawn under the control of the machine slides. In the clean delivery thus obtained much of their value lies. In England and Germany a large amount of hand ramming is adopted in machine moulding. In the States ramming is more often done by mechanical means. There would be no special difficulty in compressing sand by mechanical means over a perfectly level surface; but the surfaces of patterns are seldom level, but of more or less irregular contours, and the difficulty of mechanically ramming uneven surfaces is that the sand inevitably becomes harder and softer in different localities. It is therefore necessary to prepare special pressing plates in such cases, corresponding at least approximately with the contours of the patterns to be pressed. As the cost of these can be incurred only when a considerable number of similar moulds are required, this helps to explain why hand ramming is preferred in the majority of cases.

The patterns moulded in machines are attached to a plate—or often cast solidly with a plate—the opposite faces of which provide the faces upon which the mould joints are rammed directly, so saving the trouble and time of making sand joints. And again, it is usual, when possible, to mount several small patterns on one plate to increase the output per mould.

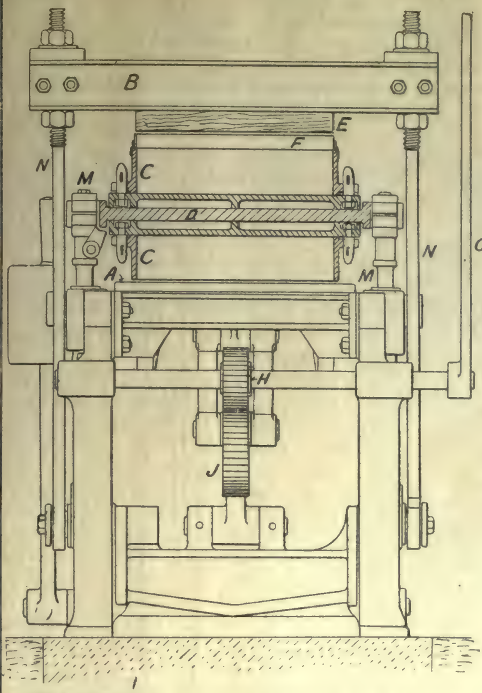
We can better understand the general methods of machine moulding if we consider in brief those methods which lead up to it, and of which it is the complete development. These are bottom or joint boards or turn-over boards, and plate moulding.

Bottom Boards. Turn-over boards, bottom boards, or joint boards, as they are variously termed, are used to save the trouble of making the sand joints each time the pattern is rammed up, or else to sustain a flimsy pattern, or to fulfil both functions at once. Different forms of turn-over boards are made to suit requirements. Perfectly flat boards are used for any flat-jointed patterns, and kept in foundries in different sizes to suit moulding boxes of various dimensions, the pins passing either through holes in the board, or beside its edge. Any flat patterns, jointed or unjointed, may be laid upon these to keep them straight while being rammed up, as pipes, columns, cylinders, thin plates, and such like. Fig. **103** shows such a board (A) maintained truly with battens. It is not quite the simplest bottom-board arrangement, because instead of a complete pattern being used, a set of half patterns is shown, and there will be another board with half patterns exactly like this for the bottom box. A halfway stage between this and the absolutely plain board is the board of the brass moulder, cut out to drop unjointed patterns into. In this, these handwheel patterns would then be complete, but solid, and sunk into the board to their central planes. Then one half box would be rammed over them, and turned over, and the board taken away, leaving the other half of the patterns exposed to be rammed. In **103**, however, there are two sets of half patterns on different plates, and no turning over is done. In this figure, note may be made of the way in which the box is confined by the corner blocks, of the runners radiating from the central ingate, and of the lifters hanging from the bars. In the upper or plan view, the bars are broken away to show the pattern arrangements clearly.

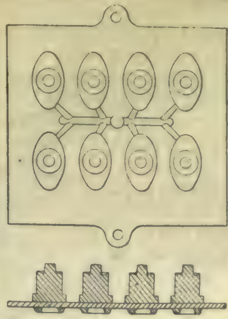
In another stage, if irregularly-shaped sand joints are required, blocks are put on the board, of shapes corresponding with the sand joints. Plate moulding in its simplest form is embodied in these arrangements.

Metal Plates. Figs. **100** and **101** show a more advanced stage. Here the plates are of iron, and the patterns are of iron or of brass, and attached to opposite sides of the plates, so that if the plate thickness were removed, the pattern portions would make up a complete pattern. In each case, sprays of runners are screwed or riveted to the plates. Fig. **102** illustrates pattern parts and plate cast together, a method adopted when the work is standardised, and in constant service from year to year.

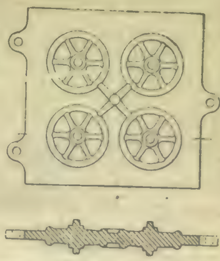
Advantages of Plate Moulding. It should be obvious that this system of plate moulding is vastly more economical and accurate than hand moulding when much repetition work has to be done. Its employment does not necessarily involve the use of a moulding machine, since there is a large amount of work of this kind done without the aid of the latter, the machine being mainly a mechanical aid to facilitate the better delivery of the pattern. Plate moulding is an extension of the use of the turn-over boards; but in the case of such boards, the pattern, either in whole or in halves, is made distinct from the board, and in the



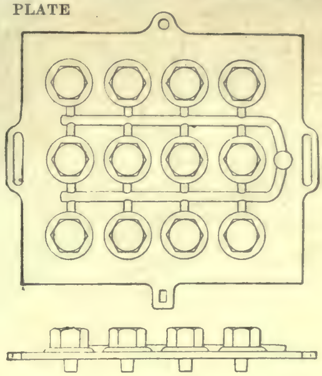
98. MOULDING MACHINE (FRONT ELEVATION)



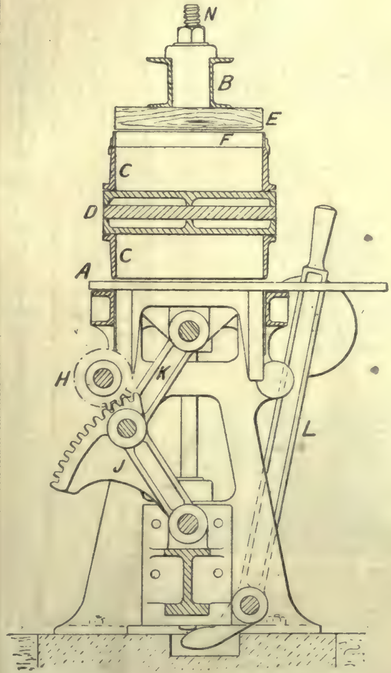
100. GLAND PATTERNS ATTACHED TO A METAL PLATE



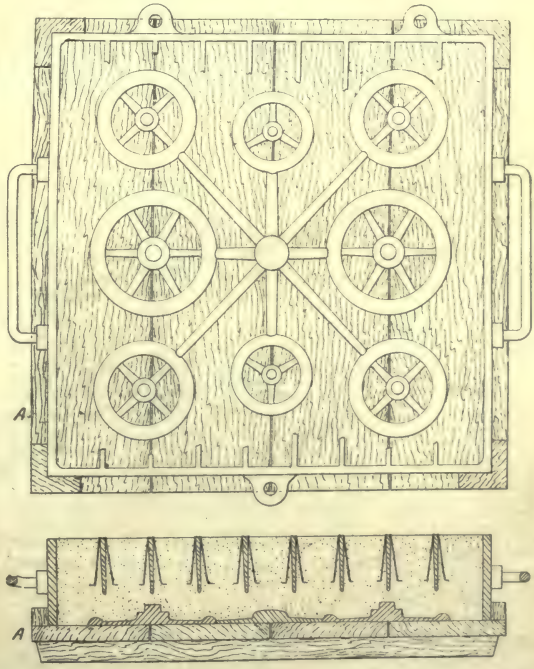
102. HALVES OF HAND-WHEEL PATTERNS, CAST WITH THEIR PLATE



101. NUT PATTERNS ATTACHED TO A METAL PLATE



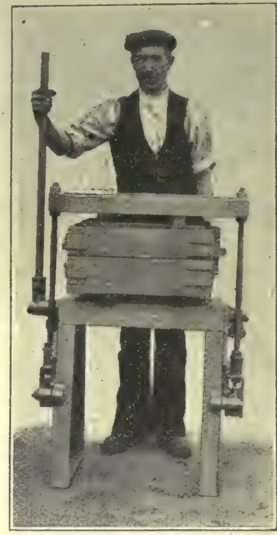
99. MOULDING MACHINE (SIDE ELEVATION)



103. BOTTOM BOARD, WITH HALF PATTERNS AND RUNNERS ENCLOSED BY MOULDING-BOX

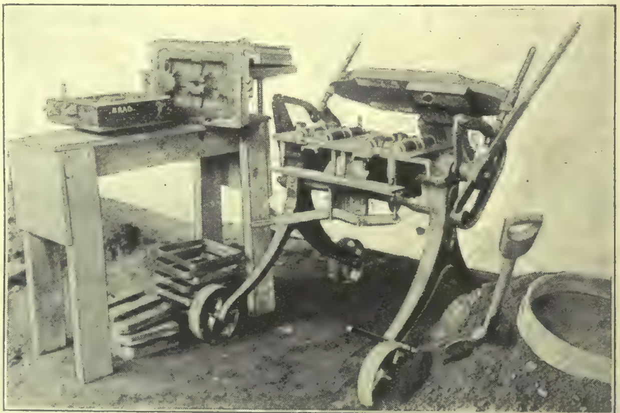
MOULDING MACHINE AND PLATE MOULDING

simplest case the latter merely forms the first sand joint face—namely, that of the bottom box part, upon which the top face is rammed; and the whole, or half pattern, as the case may be, remains in the bottom part, while such portion of it as comes in the top is also rammed at the same time as the top joint face. But in plate moulding [100–103] the faces of the sand joints do not come into contact until the final closing of the mould for casting, for each face is rammed against the joint board or plate, and the pattern sections which belong to top and bottom respectively are fastened to, or are integral portions of the board or plate itself. The principle is simply this: that whatever shape the pattern is, those portions into which it is divided by the plate would, if the plate were removed, differ in no wise from any ordinary pattern. The plate is therefore simply a piece interposed between those portions of the pattern which come in the top and the bottom boxes.



104.
HAND MOULDING MACHINE
(Samuelson & Co., Ltd.)

Patterns for Plate Moulding. In much work of this character, wood as a material of construction [103] is discarded altogether, and iron employed for plate and pattern [100–102], and often the whole is combined in one casting, as 102, which shows plate containing four hand wheels with their runners. A pattern is first prepared in wood, from which the plate with its lugs, runners, and pattern wheels is moulded and cast. The whole is then got up by filing, turning, or other suitable means, the amount of work bestowed upon it varying with the custom of the shop; some machining every portion, others leaving the faces rough, as cast, and only truing and smoothing the edges which draw vertically. After tooling, the pattern and plate are rusted over with sal-ammoniac and water, warmed, and well beeswaxed, to impart a smooth skin for delivery from the mould.



105. PORTABLE HAND MOULDING MACHINE
(The Adams Company)

A secondary advantage of the use of metal-plated work is that the evils which are more or less inseparable from the warping of timber are eliminated, and better, smoother surfaces are obtainable, and consequently better deliveries and smoother castings.

Moulding by Machine. If now, instead of withdrawing the pattern from the mould by hand or with a crane, which owing to its unsteadiness is a frequent cause of breaking down of the moulds, the plate be fitted on the table of a machine and the mould withdrawn from the pattern by a lever or a ram, perfectly plumb and steadily, the last risk of fracture of the mould is well-nigh eliminated, and this marks the perfection of plate moulding.

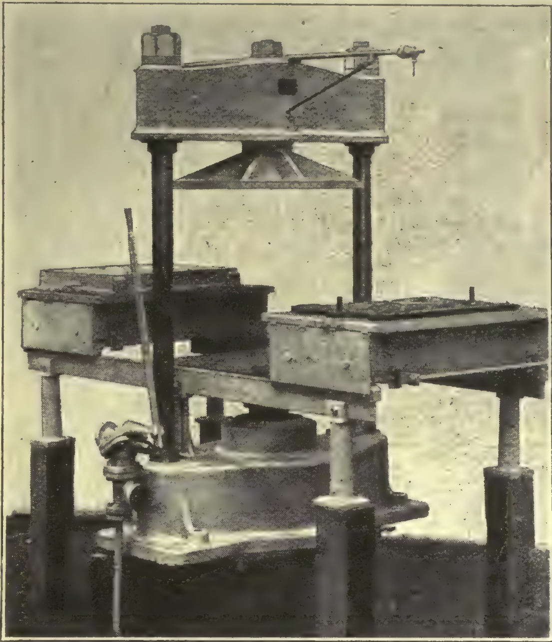
Examples of Moulding Machines. Figs. 98 and 99 illustrate in front and side elevations and part sections one type only among the many moulding machines. It is one of the most improved designs, in which the ramming, or, rather, pressing, is accomplished by power. The machine framing comprises two sides connected with horizontal stretchers. Between the table A and the crosshead B the sand is pressed into the moulding boxes, C C, which are fitted through intermediate plates with pins to the turnover table D. A presser board E attached to the crosshead pushes the sand into the box part which happens to be uppermost, the surplus sand necessary being confined by the loose frame F. The pressure is imparted by the hand lever G actuating the pinion H and toggle levers J K. The pattern and plates are lifted from the box by the counter-weighted lever L actuating the side rods M M, in the bosses of which the table can be turned over for ramming the two box parts. The crosshead B is swung aside during the filling of the boxes with loose sand, being pivoted by the rods N N.

Fig. 104 shows a plain type of machine in operation. The pressing is done by the top crossbar, pulled down by levers actuated by the long handle seen grasped by the attendant. The pair of boxes are seen between the table and the presser-bar.

In 105 we have a development of much value, the portable machine, running on wheels, so that it can be easily pushed about the foundry to any

convenient location, leaving the moulds in its wake as they are made. The half-patterns are seen on the machine table, with the presser board thrown back, while on the bench alongside are the moulds produced. Underneath the bench will be noted several of the steel bands or frames mentioned later in connection with snap flasks.

Hydraulic Moulding Machine. A hydraulic machine is illustrated in **106**, consisting of a press, with ram below and crosshead above. Above the ram the boxes are carried on rails, so that they may be run back from beneath the crosshead, and the sand filled in conveniently. Then one box is pushed along to the centre, and the rise of the ram lifts the box and presses the sand against the opposition of the plate attached to the top crosshead. Lowering the ram withdraws the pattern. In addition to the power obtained by hydraulic pressure, there is the further advantage in this class of machine that as many as four men can be set to work—two filling and pressing, and two removing the boxes and placing them together.



106. HYDRAULIC MOULDING MACHINE

Where Machine Work Scores. The examples which have been given are comparatively plain, the better to illustrate the elements of plate and machine moulding. But the full advantages of the system are most apparent in patterns of intricate forms—that is, which involve more sleeking and shaping of joint faces, etc., on the part of the moulder, more work in cutting of runners; also patterns which are moulded in very large quantities by firms who deal in specialities, and which, being usually of small dimensions, can be and are moulded several at a time on a single plate. The highest economies are secured when patterns of small and medium dimensions are grouped on plates along with their runners, and when joint faces are not plain. Patterns which are not cored, or cored only to a small extent, are more economically moulded than those in which many intricate cores have to be fitted and properly secured. Shallow patterns, and patterns without vertical edges, deliver best, but deep patterns with vertical faces are eminently suited for plate or machine moulding when a stripping plate is employed.

Wheel Moulding. The moulding of toothed wheels by machine means that a complete pattern is not required, and that the employment of mechanism produces more accurate results in the pitching or spacing of the teeth than can be ensured by hand work with a full pattern.

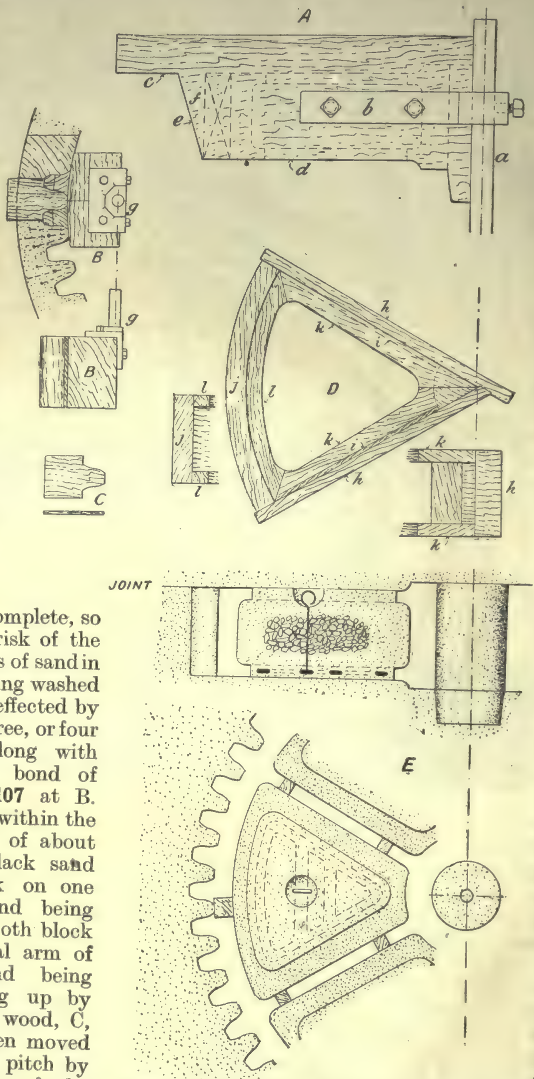
The wheel moulding machine is a dividing machine, having change wheels and worm gear for the pitching, together with mechanism for operating and withdrawing the tooth block. The cores for the arms are made by the usual methods of core making, and inserted in place by hand.

The general process of wheel moulding is as follows. The moulder is provided by the patternmaker with all necessary parts, such as tooth blocks, core boxes, etc., which vary with each type of wheel—spur, bevel, worm — and with the shape of the arms, the presence or absence of shroudings, etc. We can take only the case of a plain spur wheel with a plain top. The top box is rammed distinct from the wheel mould upon a plain level bed of sand, and calls therefore for no remark. If the wheel be large and made in the floor sand, a coke bed is provided underneath, and the whole area of the wheel is vented down to this bed. Small wheels are moulded in a bottom box. In the case of the spur wheel selected [**107**] the bed and the top joint face are made with a striking board A. On it the half section of the wheel is marked as a guide to the moulder in setting the cores. It is attached to the striking bar *a* by a strap *b*. It strikes *c*, the top joint face, *d*, the bottom of the bed, and *e*, a wall of sand, at 2 in. or 3 in. distance away from the tooth point, leaving a space *f* for the reception of the facing sand, to be rammed within and around the tooth spaces. In bevel wheels it is better to cut the board precisely to the bevel and diameter of the tooth points.

Formation of the Teeth. The ramming of the tooth block B follows. The one shown has two teeth; but many contain three or four. The more teeth used the greater the precision demanded, because each tooth space must be an exact counterpart of its fellow. Each space has, moreover, to be rammed up with the

same expenditure of labour as any other, so that the only time saved is that in elevating the block.

Having a tooth block, the spur B, shown or a bevel wheel block bolted to the carrier *g* of the machine, the radius is set by means of a strip cut to extend from the central striking bar *a* to either the root or point of the tooth, and the arm is permanently clamped in the position corresponding therewith. The block is lowered by means of the vertical slide of the machine until it touches, and just presses upon the bed struck by the board A, and the ramming up commences. The ramming must be done so that the connection between the tooth spaces and the outer body or wall of sand struck by the sloping edge of the board A shall be complete, so that there will be no risk of the narrow pillars or sections of sand in the tooth spaces becoming washed away. This union is effected by means of nails—two, three, or four being rammed in along with the sand to form a bond of union, as shown in **107** at B. Facing sand is rammed within the teeth to the thickness of about 1 in. or $1\frac{1}{2}$ in., and black sand behind, and a block on one side supports the sand being rammed there. The tooth block is lifted by the vertical arm of the machine, the sand being prevented from pulling up by holding a flat piece of wood, C, on its surface. It is then moved a distance equal to the pitch by the dividing apparatus of the machine, lowered and re-rammed, and so on, as indicated at B.



107. DETAILS OF WHEEL MOULDING BY MACHINE

The Arms. There are many different methods of formation adopted for the arms of spur wheels. The H section type is the most common, because it is the easiest to make, and the strongest. But other forms are often adopted either because the wheels are too small for H arms, or because that type would be out of harmony with adjacent gears; because wheels have to replace broken ones, or they have to be cast against something else which necessitates some other shape, or on account of the designer preferring an older type of arm. We can take only the moulding of a spur wheel with H section arms.

As usually made, the core-box is of the form shown at D [**107**] in plan and part sections. The two sides *h h* are notched together at the angle required for the arms, 60 degrees if for six arms, 45 degrees for eight, 90 degrees for four, and, the inner faces corresponding with the centres of the ribs; the thickness of ribs, *i*, is equal to half the thickness of the arms. The inside of the sweep *j* corresponds with the inside of the rim of the wheel, and the flat arms *k k* and inner ribs *l l* are divided to allow of delivery of the core. The core being rammed up, the screws which connect the sides with the sweep are withdrawn, the sweep *j* drawn away horizontally, the sides also drawn in the same manner, and the core left standing on the ramming board or bed.

The mould is shown in section and plan [**107** E] and the relations of the several parts are apparent, together with the method of gauging the thicknesses of arms and rims when setting the cores.

Continued

A SHORT DICTIONARY OF TERMS IN FOUNDRY WORK

ACID STEEL—Steel made from non-phosphoric ores.
Air Belt—The belt encircling a cupola, through which the blast is conveyed to the tuyeres.
Air Furnace—A furnace which utilises the natural draught of a chimney.
Alloy—A mixture of two or more metals, effected by fusion.
Aluminium—Used in numerous alloys. It exercises a cleansing effect.
Anchor—A moulder's chaplet.
Angle Board—Used by pattern-makers for planing angles, hollows, or fillets in.
Angles—Strips of triangular section used for fitting in corners in patterns, and for strengthening castings.
Annealing Oven—Used for the decarbonisation of malleable iron castings.
Apple Tree—Used for cogs of mortice wheels.
Arc Pitch—The pitch of gear wheels measured round an arc of the pitch line.

BABBITT METAL—A white metal used for lining bearings.
Back Plate—A cast-iron plate bolted to the back of a foundry box, for vertical casting.
Bare—Slightly under exact size.
Barrow Ladle, or Sulky—A foundry ladle mounted on a barrow framing.
Bars—The stays, or cross-pieces of moulding boxes.
Basic Steel—Steel made from phosphoric ores, in a converter or furnace having a basic lining (lime).
Bastard Wheel—A wheel which, bearing with another, is not of correct pitch or bevel.
Bead Sleekers—Moulder's tools for smoothing the impressions of beads.
Bed Charge—The bottom charge of coke in a cupola furnace.
Bedding-in—Moulding patterns in the same position in which they have to be cast, without a bottom box.
Beeswax—Used for coating iron patterns to prevent them from rusting.
Bellows—Employed for blowing particles of loose sand, dust, and blackening out of moulds.
Bench—Used by pattern-makers, moulders in small work, and by core-makers.
Bench Rammer—A small rammer used for moulding at the bench.
Bench Work—Work done at the bench, to distinguish it from that done on the floor.
Bevel Wheels—Toothed gears, the pitch planes of which form conic frustra.
Blackening—Charcoal dust, or plumbago, used for dusting foundry-moulds to prevent sand burning.
Blacking Bag—A muslin bag from which blackening is dusted over the surfaces of moulds.
Blacking Mill—A rotating cylinder containing rollers, or balls, which crush charcoal into dust.
Blackleading—Sometimes patterns are treated thus to facilitate their delivery.
Black Sand—The old sand of the foundry floor.
Black Wash, or Wet Blacking—A mixture of charcoal or plumbago with clay water, washed over the surfaces of moulds.
Blast—Air supplied under pressure to melting furnaces.
Blast Furnace—A furnace ranging from 80 ft. to over 100 ft. high, in which iron is reduced from its ores.
Blow—The period during which blast is being brought into a melting furnace, or the act of bringing it in.
Blower—A rotary machine in which an artificial current of air is produced by positive pressure.
Blow Holes—Holes in castings caused by the entanglement of gases in the mould at the time of pouring.
Body Core—A main core.
Body Flange—A pipe flange fitted on the body of a pattern.
Bosh—A tank of water for foundry use.
Boshes—The melting zone of a blast furnace.
Boss—A circular bearing pierced with a hole for a shaft or pin.
Bottom Board—A flat board on which a bottom box is rammed over a pattern.
Bot Stick—The iron rod which holds a stopper of clay at one end for closing the mouth of the cupola, and has at the other a point for tapping.
Box Filling—The black sand of the floor as distinguished from facing sand.
Boxing-up—Making a large pattern to enclose hollow spaces, instead of using solid timber.
Brass—An alloy of copper, tin, and zinc variously proportioned.
Brass Melting Furnace—Generally an air furnace receiving crucibles. Sometimes a reverberatory furnace for large masses.
Brass Moulding—The moulding for brass castings, which differs in some particulars from iron moulding.
Bricking-up—The building-up of the skeletons of loam moulds with bricks.
Bricks—Common bricks, fire bricks, or loam bricks, used in loam moulding and in lining furnaces.
Bronze—A mixture of copper and tin variously proportioned, or with aluminium or phosphorus.
Building-up—Constructing patterns with segmental pieces to ensure permanence of form.
Burning-on—Casting new metal on old for the purpose of repairs.
Burnt Iron—Cast iron which has become largely reduced to the condition of an oxide, and rotten.
Burnt Sand—Sand which has been subjected to intense heat, so that it has no coherence. It is used for parting joints.

CAMBER—Curving of castings and of their patterns.
Carbon—The most essential controlling element in cast iron.
Carbon Cores—Hard, strong cores made of conpressed carbon.
Carriage Ladle—A ladle mounted on a carriage.
Casting—The pouring or founding of the metal.
Casting Upright—Pouring a mould vertically with a view to secure soundness.
Cast Iron—An alloy of iron with carbon and other elements.
Cast Steel—Steel which has been melted and poured.
Centre Plates—Plates used for turning jointed patterns on, the plates being attached at the ends.
Centre Square—An instrument for finding the centre of a body without compasses.
Chalk—Used for whitening pattern-shop drawing-boards, and other purposes.
Chalk Line—A fine line chalked and strained tight, and snapped on a board to leave a straight chalk-mark for sawing by.
Chambered Core—A core enlarged about its central portion.
Changing Hook—A foundry crane hook with two bends for changing ladles of metal from one crane to another adjacent.
Chaplet—A metallic stud, or nail, or piece of hoop iron which affords support to a core independently of prints.
Chaplet Block—A block of wood which sometimes supports a chaplet nail.
Charcoal—Charcoal, when ground, is used for facing moulds.
Charge—The quantity of ore, fuel, and flux which is introduced into a cupola or blast furnace at one time.
Charging Door—The opening of a blast or reverberatory furnace through which the charges are introduced.
Check, or Register—The annular jointing between the top and bottom of loam moulds.
Chilling—Casting against cold iron.
Chord Pitch—The shortest distance between the adjacent centres of the teeth of wheels.
Chucking—Attaching work to lathe chucks.
Cinder Bed, or Coke Bed—A bed laid with cinders or coke at the bottom of a mould, into which the vents collect, and from which they are discharged.
Clay Plug—A plug of clay that closes an ingate until the basin is nearly filled.
Clay Wash—Clay diluted with water, and used for swabbing the bars of moulding boxes and lifters.
Clean Lift—A pattern delivery which does not damage the mould.
Clean Metal—Metal free from sponginess, scabs, and blow-holes.
Clearance—The space between adjacent gear-wheel teeth.
Coal Dust—Ground coal, to be mixed with sand for facings.
Coal Mill—A mill in which coal is ground into dust.
Coat—An application of loam, clay wash or wet blacking to a mould.
Cod—A mass of sand carried on a drawback, or other plate.
Cogs—The wooden teeth of mortice wheels.
Cog Wheel—A wheel with teeth of wood.
Coke—Used in cupolas and blast furnaces, and when ground, for mixing with facing sand.
Coke Baskets—Moulders' hand baskets.
Coke Bed—See *cinder bed*
Coke Mill—Same as *coal mill*
Cold Blast Iron—Iron smelted by cold blast.
Cold Shots—Small globules of cold iron enclosed in castings.
Cold Shuts—Lines of imperfect union in castings.
Collapsible Core Bar—A core bar which is made to fall inwards for ready removal, after the mould is poured.
Combined Carbon—Carbon in a condition of chemical combination with iron.
Contraction—The shrinkage of metal from the liquid state.
Contraction Rule—A rule longer than the common rule by the amount of contraction of iron, or brass.
Converter—The vessel in which Bessemer steel is made.
Cope—The top part of a loam mould.
Core—A central or internal body of sand.
Core Bar—A hollow bar on which cylindrical cores are swept up.
Core Board—A board cut to the profile of a core which is swept up against it.
Core Box—A framing within which a core is rammed.
Core Carriage—A carriage on which heavy cores are run into the stove.
Coring Up—Placing the cores in a mould.
Core Irons—Iron rods rammed in a core to afford a stiffening skeleton.
Core Oven, or Core Stove—An oven or stove in which cores are placed to be dried by heat.

Core Plate—A plate on which cores are swept up.
Core Print—A projection piece on a pattern, into the impression made by which a core is placed.
Core Ropes—Ropes or strings rammed in curved portions of a core, and withdrawn to leave vent holes.
Core Sands—Mixtures of strong sand.
Core Trestles—Trestles on which core boards and core bars are supported.
Crane—Used for lifting and turning over moulds and castings.
Crane Ladle—A heavy ladle which is slung and carried by a crane.
Cross—A double beam of the form of a St. Andrew's cross, suspended from a crane, and carrying suspension loops for moulders' work.
Crucible—Used in melting steel and copper alloys.
Crucible Cast Steel—Steel melted in a crucible.
Cupola—The furnace in which cast iron is remelted.
Cupola Hoist—A light hoist for lifting iron, coke, and limestone to the cupola platform.
Curving of Patterns—Patterns are curved in the opposite direction to that taken by their castings in cooling.

DAUBING—Lining a furnace or ladle with fire-clay.
Dead Head—A head of metal on a casting.
Dead Melting—Thorough melting.
Delivery—The withdrawal of a pattern from its mould.
Devil—An open cage in which a coke fire is lit for drying moulds.
Dog—A staple, or iron cramp.
Double Shrinkage—Two shrinkages must be allowed for when making patterns from which to cast patterns of metal.
Dowels—Pins uniting loose pieces temporarily.
Drag—The bottom box in moulding.
Draught—The taper of a pattern.
Draw—The same as *delivery*.
Drawback—A mass of sand carried on a plate, without a print.
Drawing Board—A board on which shop drawings are made to actual sizes.
Drop Bottom Cupola—A cupola in which the bottom is dropped to discharge the ashes.
Drop Print—A pocket print.
Dry Brush—A soft brush used for removing dust from moulds.
Drying—Driving off the moisture from moulds and cores by heat.
Drying Stove—A stove in which moulds and cores are dried.
Dry Sand—Strong sand, dried in the stove.
Dull Metal—Metal imperfectly melted.

EMERY WHEELS—Used for fettling castings.

FACE PLATE—A plate on which pattern work is turned.
Facing—A portion standing above the main surface of a pattern or casting.
Facing Sand—The sand which lies next a pattern.
False Core—The false core of a brass moulder corresponds generally with the drawback of the iron moulder.
Fan—A rotary machine for supplying blast to a cupola.
Feeder—A body of liquid metal which supplies shrinkage loss.
Feeding—Assisting the ingress of metal to the mould by the movement of a rod up and down in the runner.
Feeding Rod—A rod of ½ in. or more in diameter, used for feeding.
Fettling—Removing runners, fins, and other excrescences from castings.
Fillet—An angle, or hollow.
Fin—A thin expansion of metal spreading out from mould joint.
Flask—A moulding box.
Flat Rammer—A rammer having a flat end, used for finishing.
Floor Work—Moulding done by kneeling or bending over moulds on the floor.
Flow-off Gate—A riser gate.
Fluid Metal—Metal thoroughly melted.
Flux—Lime, which unites with earthy matter, etc., present in iron ore, forming slag.
Foundry—The building in which casting is done.
Foundry Crane—A triangular framed crane, having its top member horizontal.
Foundry Pig—Grey pig, fluid when melted.
Full—Slightly oversize.
Furnace Linings—Bricks of fire clay and ganister.

GAGGERS—Prods cast on loam plates.
Ganister—Silicious sand, and fire clay used in furnace linings and steel moulds.
Gas Coke—By-product of gas works, sometimes used in brass furnaces.
Gates—Ingates, or runners, through which metal enters a mould.
Grain—The texture of metal, or of wood.
Graphitic Carbon—Free carbon, present in grey cast iron.
Green Sand—Sand which is not dried.
Green Sand Moulding—Work done in green sand.
Grey Iron—An open grained iron, only moderately strong.
Grid—An iron frame on which a core or drawback is built.
Guide Iron—An iron curved to control the movements of a strickle.
Gun Metal—An alloy of copper and tin.
Gutters—Narrow channels cut in the joint faces of moulds for the escape of gas.

HALF PATTERN—One of the halves of a jointed and dowelled pattern.
Halving—A form of flat joint uniting pattern parts.
Handing—Making pattern parts right and left.
Hand Ladle—A small ladle carried by a single shank.
Hard Coke—Furnace coke, used in cupolas.
Hard Iron—Iron which is either highly silicious or chilled.
Hard Ramming—Ramming a mould hard, to prevent risk of lumps.
Hatching—Cutting up the surface of moulds with the trowel to assist the adherence of fresh sand for mending up.
Hay Bands—Used to bind the loam in swept-up cores.
Head Metal—A supplementary mass of metal on top of a casting, to secure soundness in the latter.
Hemp—Used instead of hay bands in small cores.
Hollows—Concave portions inserted in angles of patterns to ensure strength in the castings.
Honeycombing—A state of general sponginess in a casting.
Horse Manure—Used as a binding and venting material in strong sand.
Hot Blast — Employed generally instead of cold blast for smelting iron.
Hot Metal—Metal thoroughly melted.
Hot Sand—Sand from which recently poured castings have been removed.

INGOT—A mass of metal of rectangular section which has to be remelted for castings.
Iron—Foundry iron owes its virtue to the presence of carbon and other elements.
Iron Cement—A mixture used for joints and filling blow holes.

JAGGERS—The same as *gaggers*.
Joint—The parting of a pattern or of a mould.
Joint Board—A board on which a pattern is rammed.

LADLE—The vessel which receives molten iron from the cupola, and from which it is poured into moulds.
Lagging—Building up patterns with narrow strips of wood.
Lead—Used for lining up portions of patterns.
Leather—Used for the same purpose as lead, and for hollows.
Levelling—Necessary when work is moulded by bedding in the floor.
Lift—The act of withdrawing a pattern from the mould; or the character of the draw.
Liftering—Hanging and setting lifters in the sand of moulds.
Lifters—Hooks hung from the bars of boxes to assist in supporting the sand.
Lifting Plate—A plate attached to a pattern to receive lifting screws.
Lifting Screw—A screw with an eye used in withdrawing a pattern from the mould.
Lifting Strap—A piece of hoop iron attached to deep patterns for withdrawing them by.
Lime—A flux mixed with the charges of iron and coke in the cupola.
Lime Bag—A muslin bag from which lime is dusted over the joints of moulds, to show contact.
Loading—Weighting box parts previously to pouring.
Loam—A mixture of strong sands, rendered plastic with water.
Loam Board—A board by which a loam mould is swept up.
Loam Bricks—Bricks made of loam and dried.
Loam Cake—Pieces of dried loam.
Loam Mould—A mould made in loam.
Loam Pattern—A pattern made in loam instead of in wood.
Loam Plate—A plate on which a loam mould is built.
Loosening—Rapping a pattern.
Loose Pieces—Pieces which are not fastened permanently on a pattern body, but have to be left behind in the mould.
Lug—A projecting portion.

MACHINE MOULDED WHEELS—Toothed wheels made from sectional patterns in a machine.
Machine Moulding—Moulds in which some portions of the work are done by machine.
Malleable Cast Iron—Castings which are rendered malleable by decarbonisation or annealing.
Mending-up—Making damaged portions of moulds good.
Mending-up Piece—A piece used in mending-up, as a guide for finishing the sand outlines by.
Metal Patterns—Used when large numbers of similar pieces have to be cast.
Middle Part—The central portion of a moulding box having three or more parts.
Model—Sometimes applied to denote a pattern.
Mortice Wheel—A cog wheel, or one fitted with wooden cogs.
Mould—The structure into which metal is poured.
Moulding Box—The framework in which sand is rammed for moulds.
Moulding Machines—Machines used for producing moulds.
Moulding Tub—Used by brass founders as a receptacle for sand, and over which they work.

NAILING, NAILS—Embedded in weak portions of sand as supports.

OLD SAND—Sand which has been used continuously, and become weak.

Open Joints—Boards jointed side by side, but not in actual contact.
Open Sand Work—Moulds without a covering.
Oven Coke—Hard coke.

PAINTING—Denotes the application of wet blacking to moulds.
Paper Joint—In segmental and some other work, temporarily glued joints are made by the insertion of paper.
Parallel Print—Prints are parallel when they mould sideways.
Parallel Strips—Winding strips used for levelling mould faces and planing timber by.
Paring Tools—Long thin chisels and gouges.
Parting—The separation of the parts of a mould.
Parting Sand—Burnt sand used to prevent mould joints from sticking.
Pattern—A model from which an impression is taken in sand.
Pattern Register—A list of patterns kept in a book.
Pattern Stores—The building in which patterns are stored.
Peasemeal—A cementing material between the face of a mould and the blackening.
Peg and Cup Dowells—Brass dowells driven into the joints of patterns.
Pegging Rammer—A small rammer for small moulds and intricate portions.
Phosphor Bronze—Bronze to which a little phosphorus is added.
Phosphorus—An element which renders steel and cast iron brittle. A small quantity increases the fluidity of iron.
Picker—A pointed wire used for pulling small patterns from the mould.
Pickling—Removing the hard outer skin from castings by immersion in dilute sulphuric or nitric acid.
Pig Iron—The form in which iron is cast and sold for foundry use.
Pig-Iron Breaker—An appliance or a machine for breaking pig into short lengths for remelting.
Pine—Used more than any other material for foundry patterns.
Pipe Nails—Chaplet nails, used for supporting the cores of pipes.
Pitch—The distance between the centres of contiguous teeth in cog wheels.
Pitch Circle—The circle on which the pitch is struck.
Pitch Diameter—The diameter of a pitch circle.
Pit—A hole in which deep moulds are placed for casting.
Plaster of Paris—Used in making temporary patterns, and core boxes.
Plate Moulding—Moulding off patterns attached to jointing plates.
Platen—The table of a moulding machine.
Plumbago—Used for dusting moulds.
Pocket Print—A print which is continued above the position to be occupied by the core.
Pot Metal—A very common and cheap brass.
Pouring Basin—The depression into which metal is poured first before it enters the runners.
Print—A projection which makes an impression as a guide for the insertion of a core.
Prods—Jaggers or gaggers.
Pulling-up—The tearing-up and fracture of the sand in a mould.

QUICK—Denotes a curve of small radius.

RAMMER—A tool for consolidating sand round patterns.
Rapping—Loosening a pattern preparatory to its withdrawal.
Rapping Bar—A pointed iron bar used for rapping.
Rapping Hole—The hole in which a rapping bar is inserted.
Rapping Mallet—A wooden mallet used for rapping a pattern during its withdrawal.
Rapping Plate—A metal plate attached to a pattern to receive a rapping bar.
Receiver—A vessel which collects molten metal for pouring.
Reduction—The extraction of metals from their ores by heat and chemical affinities.
Remelting—Iron, and copper alloys are remelted to render them homogeneous and stronger.
Reverberatory Furnace—An arched furnace, with natural draught, used in some foundries.
Reverse Mould—A dummy mould of plaster upon which actual moulds are rammed.
Riddle—A coarse sieve.
Riser—An overflow exit from a mould.
Rodding—Laying rods in the sand of moulds to sustain it.
Rolling over—The same as *turning over.*
Rough Coat—A first coat of loam.
Rumble—A tumbling barrel.
Rumbling—Tumbling, or fettling in a rumble.
Runner—The channel through which metal enters a mould.
Runner Pin—A pattern for forming a runner.

SAFETY LADLE—A ladle tipped by means of toothed gears.
Saggers—The packing boxes used for annealing malleable cast iron work.
Sand—The matrix of foundry moulds.
Sand Bin—A receptacle for sand.
Sand Burning—Results from pouring hot iron against sand not protected with blackening.
Sand Joint—A moulder's joint.
Sand Mixer—A machine for mixing sands.
Sand Sifter—A machine for sifting sand.
Scab—An excrescence on a casting.
Scrap—Old metal.
Scrap Heap—A receptacle for scrap.
Scull—The scaly lining left in a ladle or furnace after use.
Segmental Work—Built-up pattern work.
Self Delivery—The delivery of a pattern having hollow portions instead of by coring.
Shank Ladle—A ladle having a handle or handles, to distinguish it from a *crane ladle.*
Shellac Varnish—The varnish used for the protection of patterns.
S Hooks—Lifters.
Shrinkage—Used in the same sense as *contraction.*
Sieve—Used for sifting sand.
Skewers—Used for holding pieces loosely to patterns.
Skimmer—A flat bar employed for baying back dirt fron the surface of metal being poured.
Skimming Chamber—A chamber in the course of a runner, designed to separate the dross, and prevent its entry to the mould.
Skin—The surface of a casting.
Skin Drying—Drying the surface only of a green sand mould.
Slag—A glassy substance produced by the union of earthy matters with calcium.
Slagging—Tapping out the slag.
Sleeking—Smoothing the surface of a mould with tools.
Slicking—The same as sleeking.
Slings—The loops which sustain moulding boxes from the cross
Soft Metal—Grey iron.
Soft Ramming—Easy ramming, which often produces lumps.
Splitting—Casting pulleys and wheels in halves.
Sponginess—Openness of texture in castings.
Spray—A series of runners arranged parallel or star-shaped.
Sprigging—Nailing.
Spring Chaplet—A chaplet formed by a loop of hoop iron.
Stakes—Bars or rods driven into the floor as guides to a top box.
Stays—Bars of moulding boxes.
Steady—An appliance used for encircling patterns of columns and pipes during turning to ensure steady running.
Stopping-off—Producing a shape in the mould different from that of the pattern.
Stopping-over—Filling up pocket prints.
Strickle—A profiled piece by which sand is scraped to any desired form.
Striking Bar—The bar to which a loam board is bolted.
Striking Board—The board by which loam, or green sand, is swept up.
Stripping Plate—A plate through which a pattern is drawn in delivery.
Strong Iron—Mottled iron, in which carbon is largely in a combined state.
Strong Sand—Sand containing loam and horse manure.
Sullage—The scoriæ of metal.
Sulky—A barrow ladle.
Sulphur—A very minute proportion of this element injures cast iron, rendering it white, and is objectionable in foundry coke.
Swab—A brush used for the laying-on of clay wash, or of wet blacking.
Swab Pot—The pot which contains clay water, or wet blacking
Sweep—A curved piece.

TACKLE—Lifting and hauling appliances.
Taper—The thinning or narrowing of patterns from above downwards.
Tap Hole—The hole from which molten metal is drawn.
Teeming—Pouring steel into moulds.
Thickness—A body of loam which represents thickness of metal.
Three-Part Box—A moulding box, comprising top, bottom, and middle.
Tile—The cover of a brass furnace.
Tinned Nails—Chaplet nails tinned to prevent rusting.
Tumbling Barrel, or Rumble—A revolving drum, in which castings are fettled.
Turning-over—Ramming the first part of a mould in the opposite position to which it has to be cast.
Turn-over Board—A board for ramming the bottom part of a mould on.
Tuyeres—The openings through which blast is directed into a blast furnace or a cupola.

VARNISH—Used for protection of patterns.
Venting—The formation of passages in moulds for the escape of gas.
Vent Wire—A rod by which vents are produced.

WASTER—A spoiled casting.
Water Bosh—A tank of water for foundry service.
Water Brush—A soft brush used for moistening the edges of moulds with water.
Weak Sand—Sand with little cohesion.
Wet Blacking—Plumbago in solution in water.
Wet Brush—A soft brush used for laying-on wet blacking.
White Iron—Iron which contains all its carbon in the combined state.
Winding Strips—Parallel strips.

YELLOW METAL—A soft variety of brass.

ZONES—The melting areas in cupolas.

Group 17
APPLIED EDUCATION
7
Continued from page 2405

ADAPTABILITY & WILL-POWER

Inimical Effects of Monotony in Life and Labour. Attributes of a Strong Character. Thought and Conduct. The Training of the Will

By HAROLD BEGBIE

NATURE abhors monotony. The force behind all material things never produces two leaves or two flowers of precisely identical condition; and if we believe with the younger school of physicists that the entire substantial globe is composed of only one material, we may see how wonderfully this force has laboured, and is still labouring, to produce infinite variety.

Variety is essential to life; monotony is inimical to life. In the case of humanity, variety in occupation is absolutely essential to vigour of mind, and we believe that many of the problems of the modern world are increasingly due to the present unscientific fashion of division of labour. The demand for an eight hours' day has certainly grown out of this division of labour, and is absolutely justified by the condition of the people. No man whose whole life is spent in manufacturing the heel of a boot or in watching the wheels of a single machine can possibly preserve vigour of mind and energy of body. All the other faculties with which he is endowed must of necessity perish under this insensate concentration, and with the atrophying of each faculty so precisely is he the less of a man.

Monotony of Occupation is Injurious. It has been truly and wittily said that an expert is one who knows nothing else. The object of existence is the perfecting of potentialities. If you have a man who might make a perfect boot, and you set him all day long to make only the heel, you infallibly destroy the object of his existence, and rob him of himself. He ceases to be what he is, and cannot be what he might become.

Lunacy, it has been said, is directly traceable to this monotony of employment. We believe that there are other causes for the alarming increase in lunacy statistics, and we are not disposed to argue that monotony of employment under modern conditions leads to absolute destruction of the reason. But we do not think that any physician will contest the point that this monotony of labour does most effectively destroy elasticity of mind and vigour of perception, qualities of the utmost value both to the State and to the individual. Dealing as we are with the individual, we base our conclusions on this contention—namely, that any specialising of study, employment, or recreation, tends to deprive the mind of elasticity and vigour.

The Foundation of Character. What are called the four Nelsonic attributes may be described as the foundation of character. These attributes are: (1) Self-reliance; (2) fertility of resource; (3) fearlessness of responsibility; and (4) power of initiative. Every one of these attributes, it will be seen, are connected with that intellectual adaptability of which we are writing. The intellectual man and the man of trade need for the success of their enterprises, just as much as the sailor for his, these attributes of individual power. There are moments when the scholar must be self-reliant, when the artificer must have fertility of resource, when the statesman must feel fearlessness of responsibility, and when the merchant must have power of initiative. These things are the fruit of education; and their destruction is the modern system of unscientific specialising.

Recreative Hobbies. Variety of occupation and variety of recreation, we have said, are the means whereby a man may enjoy intellectual adaptability. At present it is the custom of many workers to spend their free time in idleness, whereby we may see, in passing, how concentration of labour leads to the destruction of all healthful appetites. It should be the business of a man whose labour is monotonous to employ his spare time earnestly and energetically, whether it be in study or in games. This must be his first concern, the active occupation of his time. But after this the question presents itself as to the best studies and games for the purpose we are seeking—namely, intellectual adaptability.

There is great virtue in the hobby, and almost every man will find, if he examine himself, that he has in him an inclination towards some special undertaking. It may be carpentry, or gardening, or it may take the more intellectual form of some particular study, such as theology or history. Whatever it is, a man should cultivate it as well as he can, only using care to see that he does not make a monotony of his hobby. And concurrently with his hobby he must adopt some form of physical recreation which will bring into play the intellectual faculties of his mind. A good game is a game requiring some, if not all, of the Nelsonic attributes. No game is worth the playing which does not intensify consciousness and develop intellectual power. And no game, it may be said, can effect these results which is not in itself of an intensely recreative character.

Variety is Essential for the Brain. At present we inhabit a world in which a carpenter cannot whitewash a ceiling, and a house-painter cannot drive a nail into a wall. But these are not the men who force their way through circumstance to better fortune, and no man will perfectly enjoy life who is content to have his powers limited for him either by a trade society or by the conditions of his factory. It is essential to fortune, and it is essential to enjoyment of existence, that we should employ

all our faculties, should struggle to exercise every side of our being. Of the greatest importance to the State is the problem of the present unscientific rule governing our factory population—a problem which will more and more press for solution; for the individual, with whom we are here concerned, the way to adaptability of intellect is less dark and troublous, is less difficult of discernment, and is so pleasant when once entered upon that we cannot doubt of its eventual discovery by the world. There is no reason in life why a man whose bread is earned by miserable and monotonous toil should not learn to re-create himself by the means so plentifully provided for him in these days, by music, literature, painting, and even travel. The brain requires almost constant employment in varied fields, and it is as necessary for the historian to know something of literature as it is for the engineer to know something of music. The more perfectly employed the brain—that is to say, the more every faculty of our being is developed and the more our consciousness is intensified—the easier will it be to concentrate our knowledge on any one directed end of our existence. It is largely, if not wholly, a question of our own will-power, which we may now consider.

Nobody doubts the efficacy of will-power. In a loose fashion all men hold that to have the will to do a thing is half the battle of the undertaking. When we enter a contest half-heartedly and dispiritedly we are said to be beaten before a blow has been struck. Our will determines for us beforehand the issues of our undertakings.

How to Improve Will-power. Now, there are many thousands of volumes expatiating on this agreeable subject, and, for the most part, they agree that the will can be educated and strengthened in a very marvellous fashion. But, until quite recently, the authors who concerned themselves with this subject did not get so far in their investigations as to say in what manner this education could be effected. To search those thousands of volumes is to come upon much curious speculation and no little degree of insight, but to come upon no definite instruction.

Of recent years, however, patient scholars have effected some kind of synthesis of all these generalisations, and the student is now in a position to consider the matter from a more or less practical standpoint. We are encouraged to believe by various experimenters that it is as possible to train the will-power as it is to master a sum in arithmetic or to construe a passage in Latin prose.

We do not attempt any definition of the term Will. That great mystery of our being must remain a problem for many centuries of time. Sufficient for our purpose, however, is the reader's concurrence in our postulate that every mortal possesses, in greater or less degree, a capacity for selection, or an inclination of desire, and that this capacity or inclination is, or should be, the express utterance of his personality. When a man says, "I mean to do this thing," he utters the strength of his will. When another man says, "I feel sure I shall fail in this matter," he confesses the weakness of his will.

We have now to see in what manner the will may be strengthened so as to lighten any given labour and, as it were, to guarantee the success of any given undertaking. It has been discovered by scientific hypnotists that an illiterate patient will remember, and know how to perform some difficult task given during hypnosis—*i.e.*, the state of trance—long after a return to normal consciousness. It has long been common knowledge among medical hypnotists that an idea implanted during hypnosis will present itself vividly and imperatively to the normal consciousness when hypnosis has passed. For instance, a patient told during hypnotic trance that in 32,364 seconds he shall fetch a particular book from the library, or give an order for hot water to a servant, will at the appointed time do exactly as he has promised to do in trance, without any conscious knowledge of the hypnotist's injunction.

Thought and Conduct. Mr. Charles Godfrey Leland, author of the "Breitmann Ballads," was the first man, so far as we know, to apply this common fact to the question of will-power. It had frequently been advised that a person with any difficult task to perform should "will" himself to the doing of it—that is to say, that he should repeat to himself his own assurance of success. It was a phrase of the period that a man might "hypnotise" himself into believing anything. People quite rightly held that repeated assurances of confident success would in no small measure assist the mind in nervous and critical junctures. Mr. Leland believed this, and recommended this casual form of auto-suggestion very successfully in America.

But it was the fact of hypnotism to which we have referred which first led Mr. Leland to what we may fairly describe as his "discovery." He saw that the mind during sleep was active, that it performed labour of which the normal consciousness was not aware, and that the ideas which it received in sleep were, for some unexplained reason, of a remarkable tenacity. He, therefore, made certain experiments, and in the end published a book announcing the facts of his discovery. The chief and essential fact of this discovery can be briefly stated: *A thought dwelt upon in the mind just before sleep will affect the conduct of the following day.*

For instance, Mr. Leland would go to sleep holding the thought that he might work all day on the morrow and experience no fatigue. On the morrow, although a very old man at this time, he would find a day's continuous work not only unfatiguing, but positively pleasurable. In other experiments he made himself immune from anxiety and worry, and ensured a calm optimism in the midst of troublous times.

The Power of Suggestion. Now, the value of these experiments is clear. Without subscribing to any of Mr. Leland's doctrines, we may see that auto-suggestion can be made to act during the unconsciousness of slumber.

Robert Louis Stevenson was wont to think over his plots at night, and then leave it to dreams to puzzle out the mystery. Cases of this kind are numerous. The consciousness acts during sleep, and with a very little investigation and effort it can be controlled and directed into determined channels.

It is, therefore, one of the best exercises for a man anxious to cultivate his will to think optimistically and courageously before he commits himself to slumber. Particularly is this so in the case of nervous disorders. A constant repetition to the brain that such and such a misgiving is delusion, will go a great way to strengthen the will to cast out "the demon." But for the general building up and fortifying of the character, it is the general attitude of courageous certainty which is required, and it is this thought which the consciousness should accustom itself to hold both night and day. There is no question in the world that auto-suggestion exercises a direct influence upon the mind, and to neglect it as an educating force is to miss one of the most certain weapons put into the student's hands.

Master the Machinery of the Brain. There are other and minor exercises for educating the will-power, all of them useful and worthy of practice. It is a curious fact that loquacious people are almost invariably weak-willed, and that excitable and sensitive people are almost always inexact and inaccurate in their statements. It is, therefore, a wise exercise to restrain the desire to overtalk, and it is a most helpful exercise, when talking has to be done, to study to express oneself in precise, definite, and brief terms. These are, however, among the minor exercises of this matter, and considerations of a like character will suggest themselves to anyone who gives the subject his attention.

The chief end in view is to obtain perfect mastery over the machinery of the brain, to be absolute captain in one's own castle. That few men enjoy this mastery is a well-ascertained fact. The easy definitions of the theologians concerning "free will" are unhappily of no value, because they leave humanity out of their reckoning. Every physician can narrate a hundred instances in his own experience of people "sinning against their will"; of people who come with tears in their eyes, begging for deliverance from the tyranny of some dreadful and hated vice.

Free Will. Few men enjoy free will. The perfect man—free to rise, free to fall, and master of all the impulses of his being—is as rare as December's rose. But that every man may—*with training*—exercise some control over his being is, we believe, an established fact; and that every man, carrying out this training of the will-power, will enjoy an enormous advantage over the man who accepts the will which Fate has brought him, as he accepts the colour of his hair or the shape of his finger-nails, is, we are convinced—the universal faith of another generation.

The reader, if he thinks about the matter, will perceive how this reasonable and mysterious power of auto-suggestion is the real secret of all the mystery and pother which has been made about mental-healing, faith-cures, and "Christian Science."

These people merely carry to extravagant ends a fact of which every physiologist has long been aware. The will can be educated to cast off certain diseases, and in all cases to assist the physician. Therefore, when the "Christian Scientist" tells a patient not to believe that he has a headache, or a cancer, but to concentrate all his thoughts on the universal benevolence of the Omnipotent and All-Perfect Creator of the Universe, he does but counsel him to practise a little auto-suggestion for the relief of his sufferings. And as faith is of the utmost importance in this matter, it is manifest that he who believes, from religious motives, that he has no headache is more likely to influence his consciousness than he who does so only because a doctor advises it.

The Power of the Trained Will. Gradually, however, it will be perceived that the explanation of the matter is purely physiological. A thought entering the mind operates upon the general tendency of the personality either for good or ill. For instance, a nervous person believing that he is going to stammer over a word will almost infallibly do so, while a vigorous and healthy cricketer, going to the wicket with the conviction that he will make a great many runs, is almost sure to puzzle the bowlers and delay his return to the pavilion.

These things being certain, it is eminently advisable for a man to educate his will-power in a general, rather than in a particular fashion. For instance, a man beset with a particular vice should abandon all attempt to think himself out of it, and endeavour as best he may to think himself into better and more delightful tastes. The will, in other words, is always open to flattery. If the ballad-monger tells himself for a considerable time that he is the equal of Shakespeare, he may in the end succeed in writing finer lines than Martin Tupper, though at the outset he was Martin Tupper's manifest inferior.

The Value of Counter Attractions. The education of the will, we must remember, is not a matter of effort, but the result of a habit. To concentrate the thought upon bright and cheerful images is the best way of getting rid of repulsive images; but before the will can exorcise those undesirables it is first essential that it should have acquired at least an interest in the bright and cheerful images. A man striving to develop in himself a taste for art in order to save himself from the inclination to over-drinking must first have read some simple and informing manual of art before he begins to call up to his consciousness the beautiful and glowing images of the painter.

First, a taste for, or, at any rate, some knowledge of, a particular subject, then self-hypnotism to the end of victory, and the will, trained to be powerful in this particular field, will be found to have strength and vigour in all the other enterprises to which its owner commits it.

Continued

"MATTER IS ELECTRICITY"

The Ultimate in Chemistry. Properties of Electrons. The Beginning of all Things. Science Tending towards Philosophy. The Impossibility of Positive Dogma

Continued from page 2396

By Dr. C. W. SALEEBY

SO much for the fate of the electron. Let us now see whether there is anything that can be added to our knowledge of its actual properties. It is known that the course of electrons produced under certain conditions may be influenced by the approach of a magnet. They are deflected, and this deflection can positively be seen by suitable illumination of the experiment. It is by means of this knowledge that we are able to ascertain certain properties of electrons. We are enabled to ascertain, for instance, their velocity. This varies with certain conditions. It was quite lately stated that these electrons move at a speed resembling that of light. In point of fact, they do not move so fast as light. Nevertheless, the speed of light is the only one with which that of electrons can be compared. There is no material body, whether an atom or a star, that has a speed in any way comparable to that of electrons. We may say that 10,000 to 100,000 miles per second about represents the limits, so far observed, of their speed.

The Mass of Electrons. But a still more interesting question is that to which M. Poincaré alluded in the quotation on page 2395. What is the ratio of the electrical charge of the corpuscle to its mass, it having been noted already that this relation is constant for all corpuscles, from whatever " element " they may be obtained ? It has been hinted that physicists seem steadily to be approaching the conclusion that the electrical charge of the corpuscle accounts for all its mass. It is just a quarter of a century since Professor J. J. Thomson first enunciated the remarkable idea that the inertia of matter is electrical. The considerations he advanced dealt with imaginary bodies, which were extremely small, and which moved at speeds comparable to that of light. Little was it then thought, except perhaps by Professor Thomson himself, that the existence of bodies having these properties would one day be demonstrated ! When electrons were discovered the question arose whether their actual properties showed correspondence with Thomson's mathematical reasoning, and especially with his doctrine that the mass, or, rather, the inertia, of a body increases with its velocity. The assertion of Professor Thomson was that an electrical charge upon a moving body possesses inertia, due to the electromagnetic disturbance which it creates in the ether through which it passes. As its speed increases its inertia increases, and therefore its apparent mass. It has now been conclusively demonstrated, in the case of corpuscles, that their mass increases with their velocity, in accordance with the teaching of Thomson.

The Last Analysis of Matter. But this is the least important result of this inquiry, for Professor Thomson next proceeded to compare the experimental results with the results which should theoretically be obtained if we make the remarkable assumption that the electrical charge of the corpuscle can account for the whole of its mass, leaving not even what M. Poincaré calls " a little, a very little matter." Professor Thomson found that the two sets of results are in such close agreement that the minute differences between them may readily be disposed of as within the limits of experimental error. The conclusion is, then, that the whole mass of an electron is electrical—that is to say, is due to the inertia of its charge. Thus Professor Duncan emphatically says: " On this view, then, the to-and-fro motion of a pendulum and the electrical oscillations of the spark from a Leyden jar are simply two manifestations of an identical thing—the inertia of a charged body." Here, then, we have the root question of chemistry apparently answered in a phrase. " All mass is the mass of the ether; all momentum, whether electrical or mechanical, the momentum of the ether; and all kinetic energy, the kinetic energy of the ether."

In other words, in the last analysis, matter is electricity.

But there is another question which the reader will not permit us to neglect. When attempting to describe the corpuscular theory of matter, so far as it is at present formed, we declared that the electrons of the atom, being all negatively charged, tend to repel one another. They are bound together within the atomic whole by means of positive electricity. We have to conceive of the " foundation " of the atom as probably a sphere of positive electrification.

What is Electricity ? We have not completely described the new theory of matter until we have answered, or, at any rate, raised, certain questions about this positive electricity. Where does it come from ? What becomes of it when the atom disintegrates ? And in what does it subsist ? Even if there be no material basis for the electron, may there not be a material basis or foundation for this sphere of positive electrification ?

Now, it so happens that we are unable to answer these questions. The nature of positive electricity is almost incomprehensible—at any rate, it is not yet comprehended. Perhaps positive electricity consists of particles, just as negative electricity does ; that would seem probable. Yet, if it does, certain difficulties arise. For we seem to be able to explain the mass of an atom as the sum of the masses of its negative electrons. Hence it would seem that if there be particles of positive electricity they either have no mass at all or else their mass is

so small as to be practically negligible. We do not seem to be able to answer these questions at present because we cannot, so to speak, "get at" positive electricity. It is not shot forth from atoms as negative electricity is, and it seems to exist nowhere except as parts of atoms. The question of the nature of positive electricity is of supreme importance.

Did the World Ever "Begin"? In a recent lecture Professor Thomson stated that our ignorance in this respect prevents us from determining the nature of the direction of natural changes. It seems that our ignorance of the properties of positive electricity—as to whether it is compressible or not—leaves it uncertain whether "the universe began as a simple collection of homogeneous atoms, and is evolving into a complex thing which will ultimately become one huge atom, or whether it began as a complex huge atom and is now breaking down into simpler, smaller and similar atoms." The question in brief is whether the process now seen is the upward or the downward phase of evolution. Surely this tremendous alternative will impress the reader with the importance of the great gap in our knowledge for which this apparently satisfactory phrase, "positive electricity," really stands.

One comment, however, falls to be made upon Professor Thomson's words, or, rather, his use of the word "began." We must ask him by what right he assumes any beginning. We must ask him whether he is quite sure that he can really form the conception that the universe *ever* "began." For convenience, no doubt, the physicist is justified in using such a terminology as this; but before we can accept it in the stupendousness of its full meaning we must invoke the judgment of the higher studies—psychology and philosophy itself—in order to decide whether the idea of a beginning in the old-fashioned sense of "creation" can really be credited: whether we must not rather conceive of the Eternal Power that is behind the universe not as having called it into being at a particular time—our very idea of time being merely derived from our observation of material changes in the universe—but as underlying, maintaining, and sustaining it from eternity to eternity.

The Supreme Importance of the New Chemistry. Here, at any rate, we must close our long discussion of the new chemistry, of the possibility of which only the few dreamed ten years ago. It is a chemistry which is of no practical importance whatever at the moment to the practical man; it does not affect the price of sodium carbonate or coal gas, but *it deals with the fundamentals*, and we may be absolutely certain that our knowledge of fundamentals will ultimately prove to be of the utmost practical value. The hint has already been given as to how the new chemistry may lead us to the utilisation of energies beside which all the sources of energy that have hitherto been employed for human purposes are trivial.

But, while the practical importance of the new chemistry is only on the horizon, its theoretical importance is present, and is almost overwhelming. We have failed in our task if that has not been already made evident. A few stray sentences here and there will, we hope, have suggested to the reader that the theoretical significance of these extraordinary studies is not only scientific; they deeply concern philosophy as well. There is no more important question in philosophy than the nature of matter, and now that question has been answered. Again, among the supreme questions of philosophy are those which relate to the past and the destiny of the universe. These questions will ultimately be solved with the aid of the knowledge of fundamentals which men have gained during the past year or two. Again, philosophy is concerned to know whether all the diversities of the world can be resolved into a single substance. That is one of her supreme questions.

The Ultimate of Matter. Here, again, the new chemistry is of an importance which we cannot overestimate. Not only has it made the notion of 75 or 80 indestructible elements of matter seem to belong to an almost prehistoric order of thought; not only has it found the common element of all these elements; it has done much more. It would have been a great achievement even to show that, to quote Tennyson, there is "one element"—that in the last analysis all kinds of matter are one; but the new chemistry has done far more than this.

It has not merely shown us that atoms, though chemical ultimates, are not absolute ultimates, but it has shown that the apparent ultimate of which all atoms whatsoever are composed, the very ultimate of matter, is *in its turn* not an absolute ultimate. It is no more an absolute ultimate than the atom is. The new chemistry teaches us that the ultimate of matter is, in its turn, merely a particular variety or aspect of energy. If we attempted to state a category of the cosmos, writing down a list of the various things it consists of, we might graphically learn the significance of the new chemistry by comparing the length of such a list made ten years ago with the list that we may make to-day. The 75 or 80 chemical elements would have had a place in the old list. A little later their place would have been taken by the simple word "matter," it having by then been recognised that all matter is one. But now even that word would not appear, it having now come to be recognised that matter is merely an electrical phenomenon. How much further the new chemistry leads us towards an objective, scientific, matter-of-fact proof of the philosophical belief that all things are one we cannot here pause to say.

Science and Philosophy. Surely, at any rate, we have said enough to convince the reader of the overwhelming importance of these scientific facts to the philosopher, who has no interest in the details of science for their own sake but cares for them merely in so far as they may serve to aid him in his attempt to answer the question of philosophy.

But, at any rate, we must here insist upon a profoundly important truth. It is that, as science advances, it constantly leads up to philosophy; again and again the historian of scientific thought finds himself led beyond his proper province into that of philosophy. Certain types of scientific mind resent any connection between the two studies. They regard any attempt to speculate or to recognise the ultimate importance of scientific facts as unscientific. On the other hand, certain types of philosophic mind, such, for instance, as the mind of Hegel, resent deeply the intrusion of science into philosophic questions. These philosophers regard science as beneath their notice, just as the scientists to whom we have alluded regard philosophy as merely a vain kind of word juggling or else a species of poetry, except that, unlike poetry, it is not beautiful.

Nature is Orderly and Intelligible. But we should be able to avoid both of these extremely common and extremely pernicious errors. It is perhaps the most distinguishing mark of the purely scientific thought of the nineteenth century to lead up to philosophical problems. If that generalisation, which has been clearly stated by Dr. Merz, the great student of nineteenth-century thought, be true of the nineteenth century, it is more and more abundantly true of the scientific thought of the twentieth century, the achievements of which are already equal to those of half a dozen centuries in time past.

Among the great truths which the new chemistry serves to strengthen is, first of all, the truth that Nature is orderly; and secondly, that she is intelligible. The idea of the universal range of law is more or less clearly before the minds of all of us. Yet, imperfect instruments as our minds are, we constantly find ourselves confronted by facts in Nature which seem to have no reason or sense in them. They seem quite arbitrary; they simply are so and we have to accept them. Closer study invariably shows and will continue more abundantly to show, nevertheless, that there are no arbitrary facts in the Cosmos. What could be less intelligible or rational, less reasonable, more arbitrary, than the existence of some seventy-five or eighty elements into which all matter could be resolved, but which were incapable of being any further resolved? But the new chemistry has shown us that the existence of these elements and their relations to one another, their history and destiny, are capable of an absolutely rational interpretation. Even in all the multitudinous facts of chemistry, which it might be thought that no one could predict, we find causation and continuity to be absolute and the arbitrary to be non-existent.

Dogmatism is Impossible. There are many types of mind. Some readers will be annoyed at the recent sections of this course on the ground that they are not sufficiently prim, exact, and dogmatic. Other readers may be annoyed on the ground that we have made too great deductions from data that were not sufficiently secure. But, at any rate, we have done our best. It must be most emphatically pointed out, however, that the reader must read these sections with caution and reserve, not too hastily accepting any statements. Their value will lie, if they have any at all, far more in their power to stimulate and interest the reader's mind, so that he will closely follow for himself the great developments of the new chemistry, than in the actual setting forth of alleged facts. We cannot confidently say that any of the more precise details of the new chemistry are finally fixed. It is literally true to say that new developments arise every week, and that part of what was written in March comes to wear an antiquated look in April. Only those who live in the midst of it can realise the almost electronic speed with which our knowledge of these questions advances. One or two instances will be instructive, especially if they serve to show the reader that he must on no account consider his knowledge of the subject to be adequate when he has studied the preceding sections.

The Rapid Growth of Knowledge. For instance, what was said earlier in this course regarding the emanation of radium cannot now be regarded as an adequate statement of the facts. The reader must not imagine that the emanation consists entirely of immature atoms of helium. That seemed to be the probable interpretation until quite recently; but now it is necessary to recognise the further details which will be found stated above. Again, only a few lines later, we referred to the evolution of radium from uranium. That evolution has been suspected for some years, uranium having, as the reader will remember, an atomic weight of 240, while that of radium is 225. But it was very difficult to prove, and for some time the absence of any positive evidence seemed to tell against this view. Now, however, it may be taken as the fact. To some readers the question will occur—Does uranium produce an emanation, and is radium its product? Now this is a fair question, but, as far as we can judge at present, it seems to be true that uranium *produces no emanation whatever.*

Radium and the Sun. Again, in discussing the presence of radium in the sun, we insisted on the profound alteration that its presence there—which is extremely probable—must cause in our estimate of the cosmical time-table. Fully recognising the importance of the principle which Lord Kelvin called the dissipation of energy [see PHYSICS], we ask ourselves as to various sources from which energy, available for human life, may still be expected. First in the history of our knowledge comes, of course, the gravitational shrinkage of the sun as considered by Helmholtz; secondly comes the (extremely probable) presence of radium in the sun; thirdly comes the discovery of untold stores of energy in every atom of the sun and every atom of the earth—energies so abundant that all the extra-atomic energies with which we are acquainted, put together, count for nothing beside them. Thus, even if there be no radium in the sun, there remains more than a possibility of one day tapping the intra-atomic energies and extending the

life of man, who has behind him merely a brief history of a quarter of a million years, through æons and æons, inconceivably long and inconceivably numerous.

We must devote one line to reminding the reader that there is doubtless another sort of rays, called the *Delta* rays, to be added to the Alpha, Beta, and Gamma rays, already described on page 2028.

In the same section, and on the following page, it is necessary somewhat to re-read the paragraph in which an atom is compared to a solar system. There we spoke of the electrons as "constantly colliding with one another in their mad race within the atom," the result of these collisions being to expel some of them from the atomic system. Here we must remind the reader that the corpuscular theory of matter in its latest form enables us to advance very definitely beyond such a statement of the facts as we have quoted. In speaking of collisions we are using only a metaphor, and not a very good metaphor at that. We should remember how far apart the electrons are from each other, relatively to their size.

Expulsion of Electrons from Atoms. Furthermore, Professor Thomson has now provided us with a theory which makes the expulsion of the electrons from the unstable atom quite intelligible without our having to invoke any idea of collisions at all. We now believe that the electrons, or Beta rays, are expelled in virtue of the sudden transformation of a portion of the potential energy of the atom into kinetic energy, or energy of motion, which expresses itself by its power to carry some of the electrons out from the atom at the tremendous speeds we have described.

Recognising the law of the conservation of energy, we see, of course, that the new type of atom thus suddenly formed not only has fewer electrons but also contains less energy. Lastly, we observe that the moment of expulsion, though it does not depend upon a collision, is yet determined by something equally sudden, notwithstanding the fact that it indicates merely a point in the steady and agelong radiation of energy from the atom. At last a critical point is reached and the result is as sudden a cataclysm as if there had indeed been a collision.

Following our review of the preceding sections, it may be noted that Mr. Butler Burke has now published the remarkable book in which he discusses the relations of radium, or rather the phenomena of radio-activity, to the facts of life and living matter. If space availed, we might add almost indefinitely to what has already been said on this subject. At any rate, it may be noted that the reading of Mr. Burke's book cannot fail to increase the amount of attention which anyone may have previously devoted to his work [see "The Origin of Life." J. Butler Burke. Chapman & Hall].

Nature Makes No "Leaps." Yet another point, which seems to demand more insistence than has yet been devoted to it, is this—that the processes of atomic evolution are not discontinuous and sudden. The old doctrine seems to be as true of the evolution of the atom as Darwin showed it to be true, or almost entirely true, of the evolution of living things: *Natura nihil facit per saltum*—Nature does nothing by leaps. The processes of atomic change are absolutely ceaseless and continuous. It is only the consequences of these changes that suddenly become conspicuous when the atom becomes unstable. But the new and stable atom which is then formed itself proceeds to undergo continuous change. The evolutionary doctrine is true here as everywhere else. "Nothing is constant but change." For practical purposes we may assume that atoms are stable, but the most stable of them is steadily journeying, even though the journey may take ages, towards instability. Spencer's law of universal rhythm is thus illustrated here also, and, as a distinguished lady has said, "what is just upon its flight of farewell is already on its long path of return." Our attention is directed to certain striking moments in a continuous process, but we must not forget that it *is* continuous. Here, of course, is another illustration of that supreme generalisation which we express as the *continuity of Nature.*

"The Chemistry of the Carbon Compounds." And now we must pass, though very reluctantly, from our all too brief consideration of our subject, our knowledge of which will be recognised in time to come as constituting a great epoch in the history of the human mind; a subject which no one would now hesitate to regard as epoch-making, if only it were a few centuries old. We must pass to a new division of the subject, though in doing so we must again remind ourselves that all our divisions are, at bottom, artificial, and that there are not two chemistries but one chemistry. We are about to pass to what, not so long ago, was called organic chemistry. By this was meant the chemistry of those bodies which are characteristic of living things. It is quite distinct from what is now known as physiological chemistry—the study of the chemical processes which occur within the living body and play such an essential part in its life. But it has already been pointed out that the old division of chemistry into inorganic and organic is untenable, and in the next place we must devote ourselves to a brief study of the principles of what we prefer to call the *chemistry of the carbon compounds,* and of the reasons which render the use of that term desirable.

Continued

DESIGN OF VEHICLES

Principles of Vehicle Design. Space Requirements in Vehicles for Road and Rail. Influencing Factors in Vehicle Construction

continued from page 2467

By H. J. BUTLER

Railways. The road-coach design having been discarded, it was found that the girder frames on which the bodies of railway carriages were at first mounted might be used to greater advantage. The designer had not to consider any great display in external appearance, for the vehicle runs on a private highway, and is essentially a travelling carriage, not a pleasure carriage to be shown off in its beauty of outline in the park or fashionable thoroughfare. So curved lines have for the greater part been discarded, being retained in the rounding of window corners, the tops of doors, the roof lines and the turn-under sweeps. Even these small embellishments are done away with, especially in American practice, excepting the necessary rise in the roof.

The rectangular is the general type of railway carriage now prevailing both for passenger and goods stock. It is reversible, so that it fulfils its object in either direction without the need of a turntable [1, page 2462].

In the early days of evolution we see the dimensions of the road-coach retained in some degree. Roof rails for carrying the luggage, with a protecting tarpaulin and the brakesman's seat were remnants of road-coach design.

Need for Enclosed Bodies. Travelling at a good speed, we need continual protection from the weather be it wet or fine, and from the smuts and steam from the engine. Therefore, no open or convertible close-to-open vehicle is suitable, and the open-truck type soon died out, albeit after plenty of comment. How to construct a closed carriage with efficient ventilation is still, perhaps, unsolved.

The over-all width and height of a railway vehicle is governed in the first place by the loading gauge. All railways do not show uniformity in the height and width of tunnels, and different countries have their respective standards. The height of platform, the width between the up and down line, and radii of curves, are all important factors that must be considered.

As previously suggested, the introduction of the bogie at once made the use of a longer vehicle possible. Two four-wheeled bogies are now extensively used on passenger and freight types all over the world. Two six-wheeled bogies form a very easy running gear, and they may be seen on dining-cars and other stock.

Leg Room. The distance from the top of the seat-board to the floor, measured vertically as well as diagonally to the foot resting-place, should be about 15 in. in the first and 24 in. in the second instance. Having a flat floor, railway travelling is often found tiring from this special standpoint, more so than riding in a brougham, canoe landau, or other road carriage where the bottom is rounded, or the juxtaposition of the parts allows the feet to rest at an easier angle with the lower leg than is the case where an obtuse angle tends to be formed.

Knee Room. Knee room is often provided in proportion to the class of carriage. Main-line types are generally more comfortable in this direction than suburban types, although the gangway is more used in the latter. From 24 in. to 28 in. is an average distance measured horizontally between the opposite seat edges; but we see as much as 4 ft. in some new electric trains. Not only have we to provide for two sets of knees, but some allowance must be made for a gangway. Should one be travelling in a compartment carriage on the London Underground when it is crowded, the difference in knee room, especially in the later types, where the seats are set a little farther back than usual, will be recognised at once. But we cannot have more knee room in compartment types without longer bodies. Longer carriages mean longer trains, which again mean longer platforms. Even a couple of inches in a compartment would lengthen a train of ordinary length some 10 ft. besides adding to the expense of construction.

Head Room. Head room must be sufficient to allow a man to stand erect with his hat on. A traveller does not usually gain his seat immediately on entering, as he does in a good many types of road vehicles, and to maintain a crouched position for any number of paces, however few, is most uncomfortable. A height of 7 ft. 1½ in. from the floor to underneath the hoop-stick, or inside of roof, is an average for a central measurement when the arc of the roof is at its highest. Where a side corridor is used we have a similar measurement at that portion of the vehicle, and when a clerestory is used as an additional ventilating area, the depth of the same is added to the height, making about 8 ft. 6 in. over-all. As this head room is needed only in the gangway, the space left above the head of the seated passenger can be utilised to accommodate luggage racks for small articles.

The height of goods vehicles of the open type is sometimes decided by the merchandise carried. In the conveyance of commodities of light bulk it is important to pack in as few trucks as possible. Hay and straw are loaded well up to the limit. In conveying a tramcar of double-deck variety by rail the roof work has to be dismantled, and the special trucks now built are of the well type. The breakdown cranes of a railway have to be designed so as to lower down within the loading gauge when travelling. But special commercial

items such as theatrical scenery, girders, heavy ordnance, boilers, rails, boats, etc., demand a long vehicle, perhaps the longest being one used in connection with the Bethlehem Steel Works, United States of America, and measuring about 100 ft.

Length and Width of Seat. This detail, like knee room, is very often a matter of the fare paid. Anything less than 16 in. is undesirable, but generally 17 in. or 18 in. is allowed even in third-class suburban coaches. English people are familiar with the "To seat five persons" legend, and know what it means when one of those five is of Falstaffian proportions. The Great Eastern Railway and other companies have managed to get six a side by increasing the width of the carriage to a smaller clearance within the loading gauge, and here one sees the greatest number of persons carried in the smallest possible length of train. It may be interesting to note that the company mentioned hit upon the novel idea of converting the old stock to accommodate the extra passenger a-side.

The *corridor carriage* does not have a large carrying capacity. The gangway from end to end takes away much of the seating room, while kitchens, serving compartments, and lavatories curtail space still more, and one finds a larger tare weight of carriage per passenger than in the old type.

The Compartment Carriage. Americans often wonder how we can tolerate the side-entry compartment, which is looked upon as a relic of the mail-coach days, when we also have the corridor with its end doors. Besides giving a greater seating capacity in a given area, the familiar English type allows of a quicker emptying of the train at the termini, and at the intermediate stations the traveller may get in or out with a minimum of trouble. Those who travel by the London "Tube" know that they have to walk quickly to get out to the platform, in order that the quick working of the trains may be maintained. This business of hustle, the platform gates, the arrangement of the seats, the shouting of station names, is taken from the Manhattan Elevated Railway of New York. In the Great Northern and City Company's trains we see an extra side door situated in the centre to expedite the exit of the passengers at busy times. Emptying the train at a terminal station is, however, not so important as emptying the platform, which is a matter of consequence where fully-laden trains are constantly arriving at certain periods of the day.

Merits of Different Types. It may, therefore, be seen that the side-door type has its advantages as an economical and effective suburban carriage, and it may yet be seen for some years, especially in a conservative community such as ours. The coming of the "tubes," and the adoption of electrically-propelled trains, which are generally of the corridor type, will no doubt all help to discourage the compartment variety of rolling-stock. If we build corridor carriages, let us carry out the idea properly by connecting up the coaches with vestibules in order that a free passage from end to end may be enjoyed. Should the corridor be in the centre or at the left or right-hand side, it is of the utmost importance that the connecting vestibule be in one standard position, so that coaches of different companies may be made up into one properly working train. As the presence of curves on the permanent way necessitates a flexible vestibule, so one placed in the centre will undergo less wear and tear than a side one. Thus, the adoption of a central vestibule is a development that may be expected.

Under-frames. We have seen how the different dimensions lend comfort to the passenger, and the relative values of the different types in producing the result desired. Besides all this, a knowledge of the strength of materials is absolutely necessary in designing the under-frames, especially those of the long, bogie types. This is a detail that has to be carefully considered after the rough, or block plan has been passed by the traffic superintendent. Moreover, the different pillars and rails must be of sufficient strength to withstand the special stresses put upon them, and the construction should be as simple, economical, and light as possible, consistent with strength, and should be put together so as to allow of being easily repaired when occasion demands. It is also important that a safe and easy access be provided between the platform and the carriage.

Tramcars. Tramcars [3, page 2463] usually take a very useful strip out of the centres of our main roads, and even if only public opinion has to be considered, it follows that they should take up as little of the highway as possible.

It will be readily calculated that if we are to have a useful tramcar we cannot do with much less width than 6 ft. over-all for a 3-ft. 6-in. gauge, and 7 ft. in large cars, running on the standard track. Still, this added to the minimum of 15 in., allowed by the Board of Trade between two passing trams, means from 13 ft. to 15 ft. of roadway given up to this form of traction.

In double-deck trams we find that bridges seriously interfere with the height of the vehicle, and often the permanent way has to be lowered to give the necessary clearance. The length of car, type, and seating capacity is largely a matter of local conditions. In America we find the single-deck type favoured; here the double-deck is found in greater numbers. We have four-wheeled and bogie types, as in railway stock; and here again length is made subservient to the type of mounting. As the rails keep a tramcar in the middle of the highway, suitable means must be adopted to allow of easy mounting from the surface of the roadway. In reckoning knee room, we must not forget to give a comfortable distance between the backs of the garden seats, and as a car is a reversible vehicle, these seats must be provided with swinging backs. A tramcar must be capable of being driven and conducted from either end, be it mechanically propelled or of the old horse-drawn pattern.

Motor-cars. The motor-car is generally a petrol or steam vehicle built on a girder frame, which corresponds very much to the patterns already mentioned. Pressed steel frames for railway goods waggons and automobiles are often made by the same firm. Given a safe clearance from the ground to the bottom of the crank chamber, the designer is wise to get his vehicle as low to the ground as possible; 24 in. to the top of the frame compares very much in the favour of this type of locomotion when the same distance is considered in some patterns of the old horse-drawn carriage. The Mércèdes car of to-day is easy to get into, apart from any mechanical considerations. As suitable means of giving a motor-car a full lock have not yet been discovered, we must hesitate before adding greatly to the *length*, and therefore the width of road required for turning. The Ackermann type of pivoted axle arm, however much the frame may be recessed, allows of only a partial lock, and those who have designed public service cabs find that the Metropolitan Police do not approve of the room required to reverse some of these vehicles. Ladies with fine dresses do not like to enter a car from the back or going through a series of gymnastics to pass through any patent front entry. Therefore the side entry has an initial advantage in its convenience, and when it is remembered the private travelling public have been used to it for generations in the usual type of road carriage it will be realised that it has a great hold.

Leg Room. The leg room is decided by the engineer, who plans the relation of the pedals, the steering wheel, and the column according to his own idea. One sees now and then a luxuriously padded back, which the driver can never use, as he is forced to sit on the edge of the seat to reach the pedals, but this is seen less frequently than formerly.

Leg, knee, head, and seat room, however, must be as limited as possible consistent with comfort. One cannot expect to stand erect in a motor-car, although in the long types, with side entrance and cape head, a passenger of medium height can often stand upright. Likewise in the hind part of these side-entrance vehicles there is often more than enough leg and knee room.

For ordinary normal types 15 in. vertical and 22 in. to 24 in. diagonal leg room is provided. Knee room between vis-à-vis seats in broughams, landaulettes and similar types is about 19 in. or 20 in., while head room is curtailed from 40 in. to 44 in. from the seat board to under the cant rail, this being increased to 48 in. and over in types where one has to step a few paces before gaining the seat. Width and depth of seat, especially in the better classes of vehicles, is quite as generous as one could wish, 42 in. to 44 in. between the pillars for two persons at once being an apparently comfortable measurement. On front inside seats this measurement is lessened, but the chauffeur generally has occasion to complain of want of width rather than of length of seat.

By adopting more or less minimum sizes we are not building a vehicle which will cause great demand on the horse-power provided. Moreover, neatness, cost of production, and garage room, will not be unduly sacrificed.

Width. Width remains about the same as in the usual coachbuilders' productions. Width of châssis is a great point to the body-builder, especially if he has to construct a 48-in. body (three sitting abreast) between the standing pillars on a châssis some 865 mm. ($34\frac{1}{16}$ in.) wide.

Châssis Dimensions in Relation to Motor Body Sizes. There are many types of châssis, and each year these are being altered in length, width, and position of wheels. Therefore the coachbuilder finds his working drawings become almost useless owing to this continual change. The side entrance requires that we must look for the position of the hind wheel in relation to the dashboard and the height of the frame. Although a 21-in. door is the least possible dimension for comfortable entry, we often find expensive châssis being constructed without due regard to the body-builder's requirements. Width of châssis varies also, and it is a pity that the foreign châssis is, on the whole, wider, and therefore better fitted for its purpose than the home production.

A 10-ft. wheel-base should be quite sufficient to accommodate a large-sized motor body with side entrance, but so long as engineers will insist on bringing the front axle so far forward we shall continue to have cars of unwieldy length.

A châssis should be 24 in. to the top from the ground, and in length behind the dash about 8 ft. 6 in., and not less than $35\frac{1}{2}$ in. wide. From 36 in. to 42 in. should accommodate the bonnet of any engine of touring horse-power, and thus our frame should not exceed 12 ft. Other dimensions are: From dash to front of hind tyre, not less than 5 ft. 8 in., and from driver's seat to dash-board usually 24 in. The diameter of the wheels averages about 34 in.

Carriages. Horse-drawn carriages have many important differences in the matter of design to the varieties already described. Hitherto we have considered vehicles that have a foundation already prepared on which calculations have been effected, so that all strains and shocks may be safely undergone. It would be very difficult to lay down any exact laws for the guidance of the coachbuilder. Much is left to his experience and personal judgment. That opinions differ may be seen in different methods of construction and varying strengths of the members of the framework. A carriage does not run on a smooth, prepared track, although the use of some may be restricted to well-made roads. It is therefore a natural conclusion that the maker should build on the safe side in the thickness of his pillars and rails.

As the years have passed experience has taught that vehicles can be built lighter; and the adoption of suitably placed ironwork, notably mild steel, has greatly helped to this end.

Special Considerations. A coach-builder has to allow for the attachment and safe locking, whether partial or full, of his forecarriage, and a driving-seat giving a proper control of the horses, while the occupants of the vehicle must be comfortably seated, and allowed to gain the seat in comparative ease. The builder must use turn-under and side-sweep with moderation in order that these factors in the appearance of a carriage may be displayed to their best advantage. Moreover, like a motor-car, the carriage is a vehicle made to sell and to advertise its maker, hence painting and good trimming on a well-designed vehicle are essential. The dimensions mentioned in the previous section apply also to carriages. An average width of a brougham or landau door is 21 in.; the front quarters are usually an inch or two less than those behind, partly for appearance. Sixty-three inches is a length often seen in landau elbow-lines, which would apportion out into 20 in. front quarter, 21 in. door, 22 in. hind quarter. On the other hand, 7 ft. is seen in large London patterns. Eighteen inches from the ground to the bottom of the body, adding the depth of the rocker, must be divided in order to get at the height of the body step. Adding 15 in. of leg room to the height of the bottom of the body from the ground, we have the height of the seat, which with an 11-in. quarter brings the elbow-line to a distance of 44 in. from the ground. In many types of vehicles wheels of 3 ft. and 3 ft. 8 in. diameter are found suitable.

The width is determined by the length of the seat between the pillars, and, having added our pillar substances, we next allow a clearance for the hind wheel from the panel. This wheel is less at the bottom than at the top owing to the sale. From this we find our plumb spoke, spoke mortice, length of stock, axle collar, and finally the flap which determines the position of the spring.

The coachbuilder, like other vehicle builders, has to dispose of his glass frames and has to arrange for the folding heads of landaus and landaulettes. In all vehicles climatic conditions have to be considered, and the export trade of any firm calls for much thoughtful procedure.

Road Trade Vehicles. We should endeavour to construct a vehicle with as small a tare weight in proportion to the load carried as is compatible with safety. The area for actual use is decided after provision has been made for the driver, and, if it be mechanically propelled, for the works. As in motor carriages, the disposal of the engine under the footboard gives a great saving in length. In some types of horse-drawn vehicles, such as pantechnicons [2, page 2463] and mineral water vans, the driver's seat does not detract from the loading area.

In a furniture van we seek to remove a large load at once and to store it safely during its transportation. As many of the articles are heavy and require delicate handling, the load is kept low. A piano van requires great width to take at least a grand piano.

Plate-glass vans need a large flat space wherever the sheets may be placed. The floating raves are designed with that purpose. Sometimes hinged sides carry the load vertically. A brewer's dray must be strong enough to carry heavy casks, with standards capable of adapting themselves to the shape of the barrels. Hay and straw require that ladders shall be built over the horse and out at the back in order to insure a paying load per vehicle. Dairy vans, carts, and perambulators should be designed with regard to hygiene and convenient handling of the churns and cans.

Coal, refuse, and similar commodities do not demand a highly finished vehicle, but rather strength combined with effectual means of keeping the load within its barriers. A means of emptying the van quickly is often provided.

Heavy articles, such as safes, stonework, and machinery, necessitate very strong vehicles, hung low, often on cranked axles. Butchers' [14, page 2463] and fishmongers' vehicles, and those appertaining to the perishable goods' trade, are usually well ventilated. The conveyance of water, cattle, game, and timber all call for designs of a specific nature.

Barrows, Trucks, and other Hand Vehicles. These little vehicles, depending on manual effort for their propulsion, are a vast army in themselves, there being at least one large firm that makes an interesting volume simply by illustrating the varieties. We are all familiar with the baker's barrow [9, page 2463]. Its handles must be of convenient height, space must be apportioned for enough bread to last the round, and the ability to get at the last loaf must not be forgotten. The coster and his barrow with its super-imposed tray is familiar. The grocer, oilman, greengrocer and fruiterer, all have many varieties of hand-carts. The builder's brick truck, and types used for shipping baggage, are fitted with means of being handled by the crane. Then there are special trucks for handling the huge reels of wallpaper, linoleum, and virgin newspaper.

Biscuits, cakes and butter have trucks of their own for factory use, and movable tables for draining milk-cans, beer and mineral water bottles, have been ingeniously designed. Trucks are also mounted on cycle wheels, and the bodies are of iron or wooden open framework, or the body is panelled. Some types are made to run on rails. Also bakers and laundry proprietors have the bodies of their vehicles made of basket work.

Ventilation, heating, lighting, and other considerations will be treated under Body-making in a later section.

Continued

A SHORT DICTIONARY OF VEHICLE CONSTRUCTION

ARCH—(1) the cavity in the body for the reception of the front wheels in turning, or (2) the foundation on which some motor-car seats are built.

Axle—The rod connecting the wheels, either stationary or rotating with the wheels.

Axle Arm—The portion of the axle passing through the hub of the wheel.

Axle Bed—(1) the central portion of the axle (between the wheels), or (2) the bottom bed in the under-carriage.

Axle Collar—Projection which retains wheel from moving towards bed of axle.

Axle Flap—The resting place of the springs on the axle.

BACKSTAY TO WHEEL IRON—The iron stay connecting the bottom bed and the futchell or futchell stays—a continuance of the wheel iron.

Barker—A London style of carriage much after French taste.

Barouche—A four-wheeled canoe-shaped carriage with folding head to hind and flap to front seat.

Bars—Body framing otherwise than pillars.

Batten—Panel backing.

Bed—Under-carriage members, especially those carrying the perch bolt.

Bed Plate—A strengthening medium to the above.

Berline—A limousine type of motor body with a special round glass corner at back.

Body Loop—The connection between the body and hind C-spring braces.

Bogie—A four- or six-wheeled truck, free to move on a central pivot. Adapted to long rail vehicles.

Bolster—A rail carriage-builder's, and wheelwright's term for "bed."

Boot—That part carrying the driving-seat, or the panel or portion below the seat line.

Bracket—The footboard support.

Broad Lace—Wide coach lace for trimming doors, making pillar holders, etc.

Built-up Roof—Roof made of three or more ply veneer.

CANT—The geometrical assembling of the various parts of the body in order that the different bevels, position of joints, and other considerations, may be noted to effect an accurately constructed body.

Cantrail—The member which joins the tops of the standing and corner pillars.

Cape Cart—A South African type of two-wheeled cart, specially yoked to the horses.

Cape Cart Hood—A folding head used with the above and adapted to motor cars.

Carriage—A vehicle for private use, or the undergear of a vehicle.

Carrosserie (*Fr.*)—Bodywork.

Cee-spring Block—Block inserted between beds and "C" springs.

Châssis—The motor-car frame with or without its machinery.

Check Brace—A strap to prevent body swaying.

Check Spring—A spring to prevent straining of the body-springs when a maximum load is being carried.

Clerestory—An additional headroom beyond the roof proper.

Collet—The outermost nut and essential feature of a Collinge axle.

Collinge Axle—An axle with right and left-handed nuts, together with a collet for retaining the wheel.

Compass—*Of a spring* the perpendicular height of the arch of the spring beyond the straight line drawn through the eyes. *Of a bed* its deviation from the straight line (generally forward) drawn through the centre of the spring bearings.

Concealed Hinge—A hinge which is hidden when the door is closed.

Coupe—A single brougham.

Coupe Limousine—As above, but capable of holding more in hind part of body, and usually with a side light.

Cradle Seat—The driving seat in a hammercloth.

Cricket Seat—A folding seat.

Cut-through Door—A method of construction bringing the door bottom in front of the rocker.

DASH—The partition between horse and coachman, and between engine and chauffeur on most cars. The point from which the motor body builder takes his body sizes.

Dish—The deviation from the square line of a wheel.

Dog-cart—A loose term, embracing many two and four-wheel carriages.

Double Deck—Provided with roof seats.

Double Extension Cape Hood—A hood shielding both seats, yet folding only from the hind.

Double-run—Provision for a wash-blind and glass frame.

Drabble Axle—Van axle.

Dumb—A member having no spring action.

EARBREADTH—The front and hind bars of a van bottom.

Edge Plate—The internal girder of a carriage body.

Elbow Line—A constructional line drawn immediately under the bottom moulding on the fence rail.

Empattement (*Fr.*)—Wheel base.

FELLOE—Section of a wheel rim.

Felloepiece—Wheel plate bearings.

Fence Rail—The central door member.

Framing Piece—The top under-carriage member running from back of bed to back of wheel plate.

Futchell—The provision for the attachment of the shafts or pole.

GATHER—The forward inclination of the axle arm.

Glass-frame Carriers—Metal supports for the glass frame in a landau or landaulette.

Guide Colour—A coat to facilitate rubbing down.

HAMMERCLOTH—The elaborated driving seat of a dress carriage.

Hansom Cab Front—An arrangement whereby shafts stop at dash and easy access is given to body.

Head Prop (hind)—The support for the open head.

Headstock—The railway equivalent to earbreadth.

Hind Cross-stay—The connection between front of hind dumbs and perch.

Hooper—A London style typical of best British practice both in outline and methods of construction.

Hoopstick—Roof-carrying members.

Horn Bar—The (usually horn-shaped) hind bar in the top carriage.

LACE—A decorated braid.

Landau—A carriage holding four in body, capable of being open or closed.

Landaulette—A brougham-shaped vehicle with advantage of landau.

Limousine—See *coupé limousine*.

Limousine Landaulette—As a double landaulette, but with the extra portion immediately behind instead of in front of the door.

Locking Stop—A projection to limit the turning of the front carriage.

MAIL AXLE—A device whereby the wheel is retained by long bolts.

Main Side—The side members of a van bottom.

Marking Out—Apportioning out the various pieces of framing on plank.

Mylord (*Fr.*)—A victoria.

OBSERVATION CAR—A railway coach designed for look-out purposes.

Omnibus—A closed vehicle to carry many, often with roof seats.

PEDESTAL—A circular block used above or below the wheel plate to make up a thickness.

Perch—The fore and hind carriage connection.

Perch Bolt—Pivot of fore carriage.

Peters—A London style, medium lines, substantial construction.

Pillar-top—Upper part of pillar in landau or similar carriage which folds down when head is opened.

Platform Suspension—Two side and two cross springs in conjunction.

Posting Landau—A landau for postillion driving.

Pump Handle—The bar connecting the hind carriage with the body.

RAVE—The upper horizontal members of a van side framing.

Rocker—The bottom connection of standing pillars, sometimes a panel below seat line or body side.

Roi des Belges—Special curved motor body first designed for King of Belgium.

Roller Bolt—The trace connection to the splinter bar.

SALISBURY BOOT—A wooden frame covered with leather found under the hammercloth.

Saloon—A railway car designed usually with long side seats.

Sham Door Pillar—The front pillar of a victoria or gig body.

Side Sweep—The external horizontal curve of a body.

Single Deck—Having no roof seats.

Standard—The uprights in a van side framing between the corner pillars, or the ornamental uprights on the platform of a hind dress under carriage.

Standing Pillars—The pillars which receive the door.

Summer—The longitudinals of a van bottom framing between main sides.

Sway Bar—Extra hind felloepiece.

Sweep Piece—The wheelwright's felloepiece.

TARE—The unladen weight of a vehicle.

Tilt—A van cover.

Tonguing Piece—The connection between the front of the transom and the front of the wheel plate.

Top Carriage—The upper part of the fore carriage including wheel plate.

Tramcar—A rail street omnibus.

Transom—The top bed carrying the perch bolt.

Turnunder—The curved vertical contraction of a carriage body.

UNDERSPRING—The side spring in a C-spring under a carriage.

VACUUM BRAKE—The railway brake applying its power by the destruction of a vacuum.

Van—A four-wheeled trade vehicle, or a closed railway vehicle not adapted for passengers.

WESTINGHOUSE BRAKE—A railway brake applying its power by the lowering of atmospheric pressure.

Wheel Base—The distance between the two axle centres.

Wheel Iron—The connection between the futchell jaw and axle bed or splinter bar and axle bed.

Wheel Iron Head—The clip that encircles the axle bed end.

Wheel Plate—The turning plate of the fore carriage.

Wheel Track—The distance between the tyre centres.

Wing—(1) a mudguard, or (2) an additional side member to the hind end of a wooden perch.

Group 13 GEOGRAPHY 18 Continued from page 2409	# THE GEOGRAPHY OF ASIA Coastline. Mountain Systems and Tablelands. Roof of the World. Himalayas. River Basins. Inland Drainage. Climatic Conditions. Isotherms. Rainfall

By Dr. A. J. HERBERTSON, M.A., and F. D. HERBERTSON, B.A.

The Continent as a Whole. Asia, the largest of the continents (17,000,000 sq. miles), is surrounded by the ocean except in the west, where it is continuous with Europe. The frontier between the two does not correspond with natural features save in the Urals and Caucasus.

Coastline. The northern shores of Asia are washed by the Arctic Ocean, with one great gulf, the Kara Sea, shut in to the west by the island of Novaya Zemlya, and smaller gulfs, where the north-flowing rivers form estuaries.

The eastern coast is curiously symmetrical in the arrangement of its lands and seas. The lines of North-eastern Asia and the peninsula of Kamchatka, east of the Sea of Okhotsk, correspond closely in outline with (1) Amuria and Korea, east of the Yellow Sea; (2) China and the Island of Hainan, east of the Gulf of Tongking; and (3) Indo-China and the Malay peninsula, defining the Gulf of Siam. A sort of festooned fringe of islands extends from Kamchatka to the islands of the Malay archipelago, separating four enclosed seas from the main Pacific Ocean. These are (1) the Sea of Okhotsk, enclosed by Kamchatka, the Kurile Islands, and Sakhalin, and opening by the La Perouse Strait, between Sakhalin and the northern island of Japan, to (2) the Sea of Japan, enclosed to the east by the islands of Japan. The Strait of Korea in the south, between the Kiusiu island of Japan and the Korean peninsula, to (3) the East China Sea, enclosed on the east by the Lu-chu islands and Formosa. (4) The South China Sea is enclosed on the east by Formosa, the Philippine Islands, and Borneo, the largest island of the Malay archipelago. This archipelago, together with New Guinea, connects Eastern Asia with Australia, which many ages ago was part of the Old World.

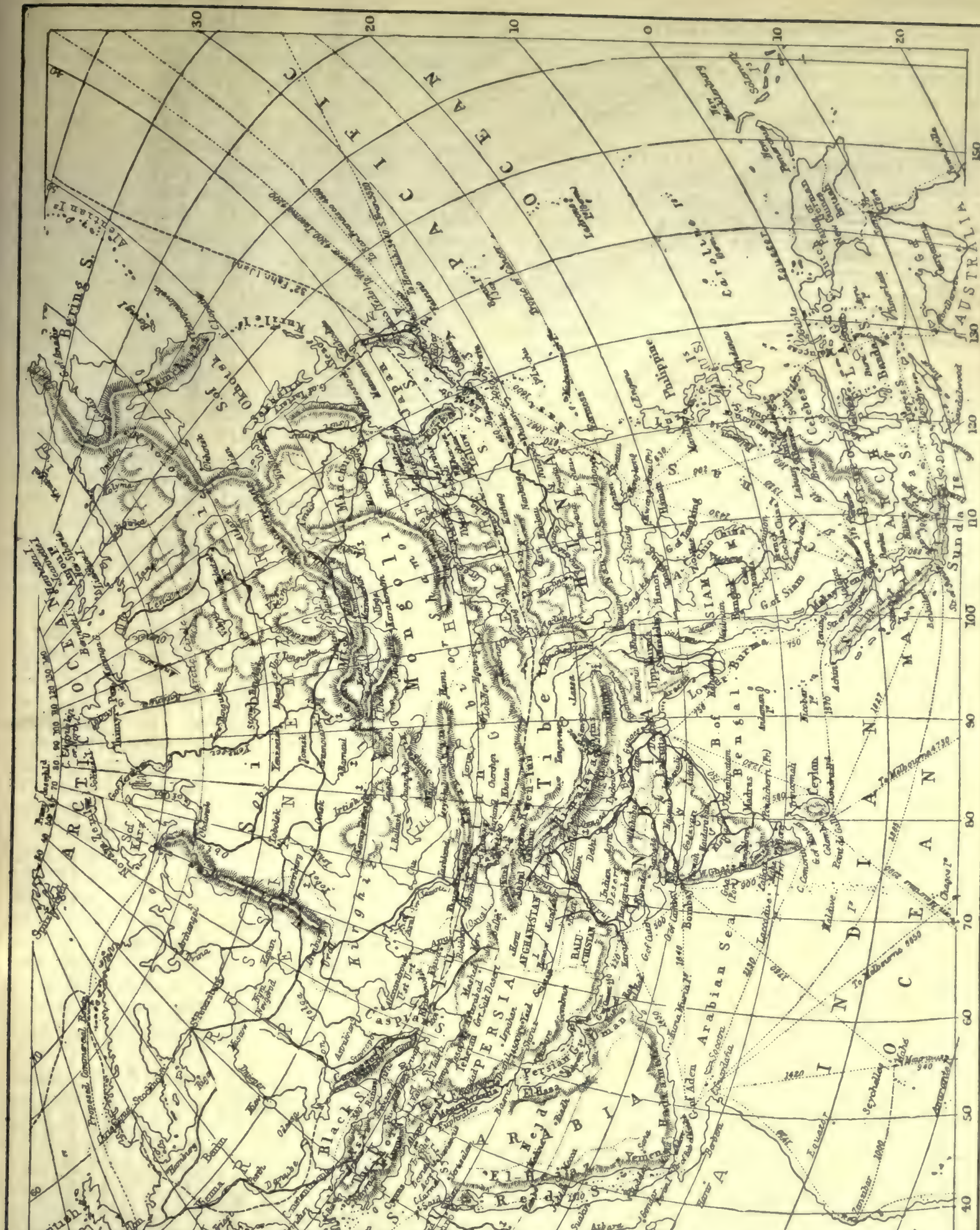
The southern coast of Asia is washed by the Indian Ocean. Like Europe, it is broken into three south-running peninsulas; (1) the Indo-China peninsula in the east, separated from (2) India, the middle peninsula, by the Bay of Bengal; and (3) Arabia in the west, separated from India by the Arabian Sea, which opens to the Persian Gulf. West of Arabia is the narrow Red Sea, separating Asia from Africa, and divided from the Mediterranean only by the narrow Isthmus of Suez, across which a ship canal has been cut.

Mountains and Rivers of Asia. We have seen that Europe and Asia really form a single continent, and that the physical features of the two are continuous. Broadly speaking, Europe is a lowland in the north and a highland in the south, and these divisions are represented in Asia by the plains of Siberia in the north, and the mountains of Central Asia. South of the latter are a series of lowlands: Mesopotamia, or the lowland of the Euphrates, in the west; the lowlands of the Indus and Ganges, or the plain of India, in the centre—both of which we may compare with the plain of the Po at the base of the Central Alps—and smaller lowlands in the east, round the rivers of Indo-China. Beyond these lowlands is the tableland of Arabia in the west, which may be compared with Spain, and the tableland of the Deccan, occupying the southern half of the Indian peninsula.

The Mountains of Asia. More than half of Asia is over 1,500 ft. above sea level. Its vast and complicated mountain systems, far greater in area than the whole of Europe, are the greatest highland area in the world in length, breadth, and height.

We began our study of the central European highlands with the Fichtel Gebirge, and of the Alps with the St. Gotthard, and similarly, dealing with the immensely complicated relief in Asia, we shall begin by looking for a centre from which the principal mountains and rivers radiate. This we find in the Pamirs, where the frontiers of Britain, Russia, China, and Afghanistan meet. They form a desolate plateau, some 150 miles both in breadth and length, which the inhabitants well call the Roof of the World.

The Roof of the World. This is how the Roof of the World is described by a traveller approaching it from the north. "Approaching this interesting region from Kashgaria, one sees clearly how it has acquired the name of the Roof of the World. The Pamir mountains rise apparently quite suddenly out of the plain, from a height of 4,000 ft. above sea level at their base, to over 25,000 ft. at their loftiest summits, a massive wall of rocks, snow, and ice. Once through the gorges which lead up from the plains, one enters a region of broad, open valleys separated by comparatively low ranges of mountains. These valleys are known as Pamirs, a term applied by the natives of these parts to a particular kind of valley. In the Hindu Kush and Himalaya regions the valleys, as a rule, are deep, narrow, and shut in. But on the Roof of the World they seem to have been choked up with the débris falling from the mountains on either side faster than the rainfall has been able to wash them out, and so their bottoms are sometimes as much as four or five miles broad, and almost level. These Pamirs vary from 12,000 or 13,000 to 14,000 ft. above sea level—that is, the bottoms of these Pamir valleys are level with the highest summits of the Alps."



104. MAP OF ASIA

For the greater part of the year they are buried in snow, but during the few weeks of summer there is a fair abundance of coarse but nourishing pasture, which attracts a few wandering Kirghiz herdsmen and their flocks to this desolate region.

The Pamirs as a Mountain Centre. From the Pamirs radiate the chief mountain systems of Central Asia. These are (1) the Tian Shan, running north-east, in a direction which is continued by the Altai, Yablonoi, and other mountains which form the northern rampart of the mountain core of Central Asia. From the northern valleys of this rampart, which slopes to the vast plains of Northern Asia, descend the rivers of Siberia—the Ob, Yenisei, and Lena—while the great Amur, flowing east to the Sea of Okhotsk, gathers up the waters of the southern and eastern valleys. Between (1) the Tian Shan and (2) the Kwenlun, the next well-defined system radiating east from the Pamirs, are enclosed the Tarim basin and the tableland of Mongolia. Besides forming the southern wall of this plateau, the Kwenlun is, as it were, a natural stair leading to a still loftier plateau, whose valleys lie but a few thousand feet below the summits of its highest peaks. This is Tibet, the highest inhabited land in the world. The next system is formed by (3) the Karakoram, or Muztagh Mountains, and (4) the mighty Himalayas, the most imposing system in the world. Its northern ranges form the southern rampart of the Tibetan plateau, while the southern descend steeply to the plains of India, 20,000 ft. or more below.

The Himalayas. No words, or even pictures, can give an idea of the wonders of the Himalayas. Seen from the plains of India, they consist of low hills, not over 2,000 ft., with ranges behind rising to 8,000 or 9,000 ft., and behind these again, to snowy summits, over 25,000 ft. At the base lies a broad strip of malarious jungle, called the Terai, with a heavy rainfall and continuous floods, so that the water-logged soil is pestilential with decaying vegetation. Above this is the forest zone. The ascent is very rapid. In 35 miles the railway to Darjiling, in the Sikkim Himalayas, climbs over 7,000 ft. "The whole range may be described as a stupendous stairway hewn out of the western border of the Tibetan plateau by glaciers and great rivers. It is cut into countless peaks and ranges, with valleys of corresponding depth, down which dash thundering torrents. The deep gorges of the rivers so interpenetrate the mountains as to carry a hot climate far along their banks, till the semi-tropic vegetation becomes almost overhung by snowy peaks." This is true only of the valleys opening south to the plains of India. Those enclosed between the ranges of the Himalayas are as terrible in their desolation as in the wild character of their scenery.

A Himalayan Road. Lord Curzon thus describes his march along the upper valley of the Hunza, a tributary of the Indus: "The river cuts a deep gash or furrows an uproarious channel in its descent from the watershed of the Pamirs. Big glaciers propel their petrified cascades to the very edge of the river. Sometimes the road is conducted round the edge of the precipices that overhang the torrent by artificial ladders and ledges, built out from the cliff with stones loosely laid upon supports of brushwood and timber jammed into the interstices of the rock. Over this vile stretch of country there are two tracks, the upper, or summer track, which avoids the river-bed, filled with a fierce and swirling torrent, and climbs to the summit of the cliffs, several thousand feet above the water, and the lower, or winter track, which can only be pursued when the melting of the snow by the hot summer sun is over, and the river dwindles to a number of fordable channels, across and amid the boulder-piled fringes of which the traveller picks his way." Up very similar roads lay a great part of our Army's ascent in 1904, by the gorges of the Sikkim Himalayas to the plateau of Tibet above. They made their way through dense forests, with a hothouse temperature and tropical vegetation, through woods of oak, chestnut, maple, ash and elm, through open snow and sprinkled pine-forest, emerging at last above the blazing rhododendrons which grow just below the snow line into open, undulating stretches of Alpine pastures, in full view of the great snow peaks.

Peaks of the Himalayas. Only a few of these can be named, for there are scores of peaks over 20,000 ft., presenting some of the finest scenery conceivable. In Kashmir, through which the Pamirs are approached from India by the Hunza Valley, the peak most admired by travellers is Nanga Parbat (26,600 ft.). In the Himalayas of Nepal is Dhaulagiri (26,800 ft.), while the monarch of the Sikkim Himalayas is Kanchenjunga (28,200 ft.), surrounded by peaks almost as high. Chamalhari (24,000 ft.) greatly impressed our troops who passed close below it in the Tibetan expedition, but the monarch of the Himalayas, as of the world, is Mount Everest (29,000 ft.), first seen from the Tibetan side in all its grandeur by European eyes in the summer of 1904. Hitherto the giant had been seen only from the south, almost completely hidden by the mighty peaks between.

A Glimpse of Mount Everest. "Towering up thousands of feet, a glittering pinnacle of snow, rose Everest, a giant among pigmies, not only on account of its height, but for its perfect form. To the east and west, but nowhere in its immediate vicinity, rise other great mountains of rock and snow, each beautiful in itself, but in no way comparing with the famous peak in solemn grandeur. It is difficult to give an idea of its stupendous height, its dazzling whiteness and overpowering size, for there is nothing in the world to compare it with." Thus writes the first Englishman who saw it, settling for ever the doubt whether still higher peaks might not exist on the Tibetan side. For the present, Mount Everest reigns as the unchallenged monarch of the world.

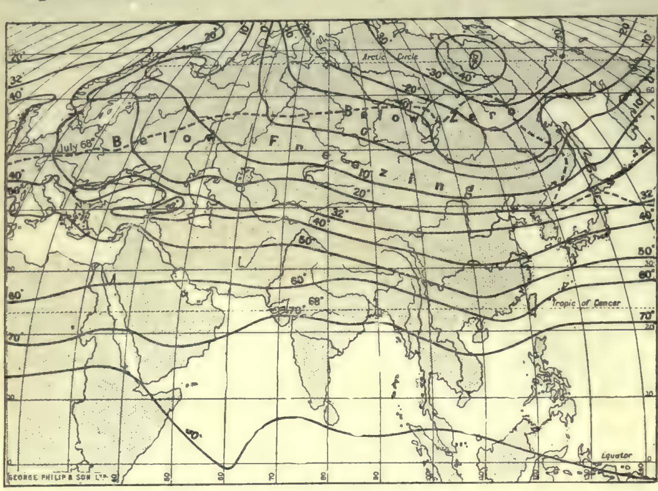
The Hindu Kush. Returning to the Pamirs, to reach which from Mount Everest we should have to cross Tibet and Kashmir

105. THE ROOF OF THE WORLD

by innumerable passes thousands of feet higher than the highest summit of the Alps, through some of the grandest and some of the most desolate scenery in the world, we now continue our examination of the mountain systems connected with the Roof of the World. They no longer run east, but west, interposing a mountain barrier hundreds of miles wide between the plains of India and the steppes of Russian Asia. They are known as (5) the Hindu Kush, the direction of which is continued west by the Elburz Mountains, at the southern margin of the Caspian Sea, to the highlands of Armenia, the centre of the West Asian mountain systems, and (6) the Suleiman Mountains, which run south, and form the western wall of the plains of India and the eastern rampart of the plateau of Iran, a smaller and lower Tibet.

The Rivers of Central Asia. We can now fill in the rivers connected with the great mountain systems of which the Pamir plateau is the centre. The glaciers of the western valleys of the Pamirs and the northern valleys of the Hindu Kush give birth to the feeders of the famous Oxus, or Amu Daria, which leaps down through stupendous and often impassable defiles, between walls of bare, treeless rock, to the lowlands of Turan, whose dry sands it crosses to the land-locked Sea of Aral, to which also flows the Jaxartes, or Syr Daria, from the Tian Shan. From the north-eastern glaciers of the Karakoram, above which peaks rise to over 28,000 ft., rushes down the Yarkand river, which unites with many other raging streams from the Tian Shan and Kwenlun to form the Tarim. The Tarim crosses the deserts of Eastern Turkestan, and loses itself at last in the marshes of the disappearing lake of Lob Nor. Greater than either of these is the mighty Indus, which rises deep in the fastnesses of the Himalayas, its upper valleys forming a series of appalling defiles, through which an inky torrent thunders at the base of sheer walls of rock, many thousands of feet in height. It is turned south by the wall of the Hindu Kush, and flows south-west at the base of the Hindu Kush and Suleiman Mountains to the Arabian Sea. As it crosses the plain of Northern India it receives many long tributaries from the Himalayas, the greatest being the Sutlej, which has risen not far from the Indus itself, and broken through range after range of the Himalayas in its wild course to the plains below. A third river, rising quite near the Indus and the Sutlej, but finding its escape along the Tibetan base of the Himalayas, is the Brahmaputra, whose course follows the direction of the Himalayas till these begin to break up and bend south. Then the Brahmaputra also turns south, and, leaping down the mountain terraces of Assam, flows at last to the delta of the Ganges. The Ganges is formed by the union of many great rivers, which thunder down in parallel valleys

from the southern slopes of the Himalayas, their sources not far, as the crow flies, from those of the feeders of the Indus and Sutlej, but separated from them by what are, for man, insuperable barriers.



106. JANUARY ISOTHERMS
The July isotherm of 68 deg. is indicated by a broken line

The Mountains and Rivers of Indo-China. In the wild and little-known regions on the frontiers of Tibet and Eastern China, at the eastern end of the Kwenlun, we have another of those central points from which a whole series of mountains and rivers radiate. Here the Hwang-ho, or Yellow River, of China rises in the mountain fastnesses of north-eastern Tibet, leaps down to the plateau of Mongolia, and breaks away south across the North China highlands, which spring from the eastern Kwenluns and mark the end of that long line of elevation, running from west to east, which we have traced from the shores of the Bay of Biscay to the eastern confines of Asia. Here, where it ends, internal convulsions have crumpled the Earth's crust into complicated folds, which diverge in all directions, north-east in the North China highlands, east in the highlands which separate the Hwang-ho from the Yangtse-kiang, the second great river of China, and south in the parallel ranges which lie east of the Himalayas and the valley of the Brahmaputra. A whole series of parallel valleys, running first east and then south, are filled by the tributaries of the Yangtse-kiang and by the upper courses of the rivers of Indo-China, the Irawadi, the Salwen, and the Mekong.

The Armenian Highlands. To the highlands of Armenia, between the Black Sea and the Persian Gulf, converge (1) those mountains which continue the direction of the Hindu Kush and form the northern rampart of the plateau of Iran, and (2) those which spring from the base of the Suleiman Mountains and are continued along the Persian Gulf to the mountains of Kurdistan, forming the southern rampart of the same plateau. From the Armenian highlands diverge to the west the northern and southern mountain-walls of the plateau of Asia Minor, the latter known as the Taurus Mountains. The rivers of the Armenian highlands are the Euphrates and Tigris, flowing from the southern valleys to the Persian Gulf, forming in their lower courses the plains of Mesopotamia, and the Aras or Araxes, flowing east, and separating Armenia from the Caucasus.

The Mountains of Eastern Asia. Volcanic activity is very conspicuous in Eastern Asia, where a broken chain of volcanic mountains runs through Kamchatka, the Kurile Islands, Japan, the Luchu Islands, the Philippines, and some islands of the Malay archipelago, where disastrous manifestations of volcanic energy occur from time to time.

Basins of Inland Drainage. We saw that one large river of Europe, the Volga, flows, not to the open sea, but to the land-locked Caspian, which occupies part of a great depression which may be traced as far as the Sea of Aral. Areas drained in this way to lakes or inland seas are called basins of inland drainage. We have had other examples in the Amu Daria and Syr Daria, both flowing to the Sea of Aral, and in the Tarim, which loses itself in the marshes of the vanishing lake of Lob Nor. The total area of inland drainage in Asia is estimated at 4,000,000 square miles, an area greater than the whole of Europe.

The Desiccation of Asia. Lake Lob Nor is disappearing because it is gradually drying up. There is some evidence to show that the climate of Asia is probably slowly becoming drier. Not merely are some of the lakes and rivers shrinking, but the desert sands seem to have invaded once fertile tracts. "Whole kingdoms have disappeared, many cities have been swallowed up in the sands, and certain tracts formerly accessible to travellers can no longer be visited owing to the total absence of water and vegetation."

Climate of Asia. We now know enough about geographical laws to find out a great deal about the climate of Asia. We have many data to go upon. In the first place, Asia stretches from about lat. 77° N. to within 100 miles of the equator, which crosses the islands of Sumatra and Java. This gives every possible variety of climate so far as this is affected by latitude. The regions round the Caspian and Aral Seas are below sea level, while Mount Everest is nearly six miles above it. This gives us every variety of climate so far as this is determined by elevation. Thirdly, the continent is enormously longer and broader than Europe, and on one side it is surrounded by the land masses

of Europe and Africa, so that no oversea winds can come from that quarter. Further, while Europe is broken up into peninsulas and inland seas, Asia is extremely compact, so that while places in the centre of Europe are only hundreds of miles from the sea, in the centre of Asia they may be thousands, and between them and these distant seas are interposed ranges of lofty mountains which intercept all oversea winds. Putting all these facts together, we should say (1) that the climate of Asia is very varied, and (2) everywhere extreme, but (3) most extreme in the centre of the continent, and (4) that, except round the margin of the Pacific and Indian Oceans, the rainfall must be scanty, and (5) that the interior must be practically a rainless desert. This is exactly the real state of the case.

January Isotherms. In the maps which show the isotherms for January, we see the distribution of winter cold. We do not expect to find the great southward sweep of the winter isotherms which was so marked in the case of Europe, for this indicated a change from oceanic to continental climate. There is no such sharp transition in the case of Asia, which has the continental climate of Russia in a more intense form. The increasing severity of the winter cold as we go east is indicated by a steady instead of a sudden dip southwards. The isotherm of 32°, indicating freezing point, which we traced in Europe as far south as the Black Sea, crosses the Caspian Sea, the Upper Oxus, and the lands north of the Himalayas, and then curves northwards through Korea, and north of Honshiu, the largest island of Japan. South of this line, which runs much further south than the most southern point of Europe, there are no continuous frosts in the plains, though any degree of frost may be experienced at a sufficient elevation. North of it frost lasts weeks or months, its severity and duration increasing as we go further north, higher, or further into the interior. The line of 0° F., indicating 32° of frost, includes most of the north-eastern part of the continent, and this is not the minimum winter temperature in Northern Siberia, for at Verkhoyansk it is under—50° F. South of this isotherm of 32° the combined influence of low latitude and proximity to the sea is markedly felt. The isotherm of 50° is comparatively near that of 32°, and the lowlands of Arabia, India, Southern China, and Indo-China, have winters as warm, or warmer than this. The winters of the southern lowlands of the three peninsulas are considerably warmer than the summers of the Thames Valley, the warmest part of the British Isles.

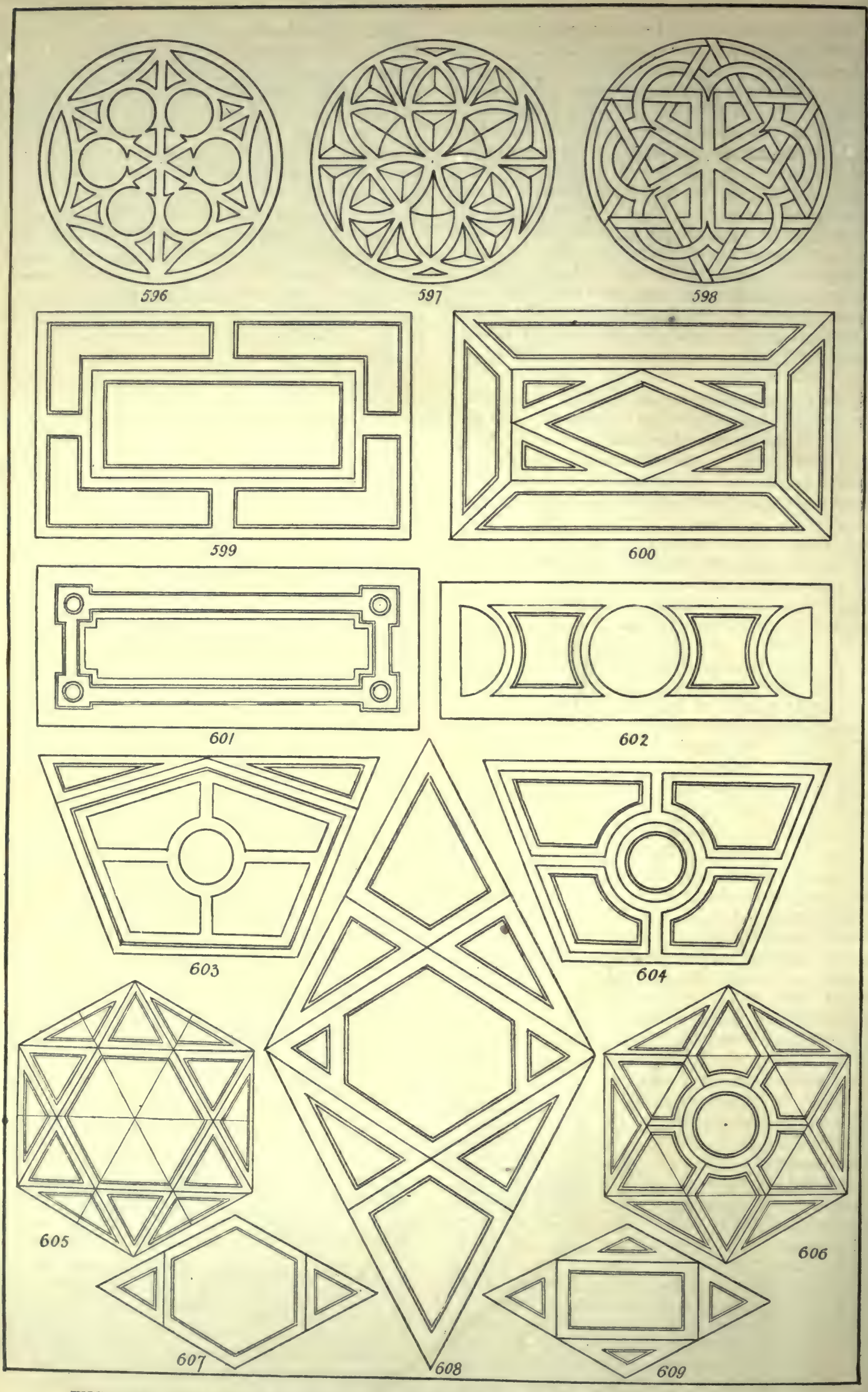
July Isotherms. The summer isotherms show us, as we might expect, that the hottest summers occur in the southern part of the continental area proper, in which we may include most of Arabia, as the seas on either side are too narrow for cooling winds to develop. The true peninsular regions—the extreme south of Arabia, the Deccan, and Southern Indo-China—are somewhat cooler, though, of course, very hot. The isotherm of 68°, the summer temperature of the hotter parts of Central Europe, extends considerably north of Lake Baikal, but sinks southwards in Amuria, and passes completely north of Honshiu. Even in the tundra the summer temperature is as high as 50°. As the winter temperature of the same place is many degrees below freezing point, the range of temperature is enormous, especially in the centre and east.

Rainfall. Turning to the rainfall, we find that five great areas: (1) in Northern and Eastern Siberia, (2) in Russian Turkestan, (3) in Chinese Turkestan, (4) in Iran, and (5) in Arabia, receive less than 10 in. of rain in a year, and are rainless deserts except where irrigation is possible. These are surrounded by equally extensive regions where the annual rainfall is under 20 in., as dry, that is, as the drier parts of Spain and Russia. The only well-watered regions are maritime China, Indo-China, and India south of the desert, round the Lower Indus. Parts of Southern China, North-east India, Burma, Siam, and the Malay peninsula have a very heavy rainfall, as have also the Western Ghats, the western mountains of peninsular India, and the Malay Archipelago.

107. THE RAINFALL OF ASIA

The Monsoons. Some of these wet areas lie in the equatorial belt of rain at all seasons, but much of the rainfall of Southern China, India, and a small wet area in South-west Arabia, is brought by the summer monsoon, the cause of which has already been explained.

Continued



ENCLOSED ORNAMENT FOR CIRCLES, OBLONGS, TRAPEZIUMS, HEXAGONS, AND RHOMBI

GEOMETRICAL DESIGN

Ornament for Oblong and other Panels. Gothic Tracery. Construction of Arches, and Greek and Roman Mouldings

By WILLIAM R. COPE

Ornament for the Circle. Fig. **596** is a mediæval design for a wrought-iron key handle; **597** is a Gothic design for chip-carving; and **598** is taken from a Romanesque portal, designed in the twelfth century.

The Oblong Panel. The usual subdivisions of this shape are shown in **599** and **600**, while **601** is suitable for a tablet, and **602** for door panels or the soffits of arches.

The Trapezium Panel. This shape may be divided as indicated in **603** and **604**.

The Hexagonal Panel. Two examples of the usual subdivisions for panelling are given in **605** and **606**.

The Rhombus Panel. This is often called the "Lozenge" shape, and may be subdivided as in **607** to **609**.

GOTHIC TRACERY

The Gothic style evolved and brought to perfection a characteristic decoration known as Tracery, by means of arcs of circles. These designs possess great originality, and richness of form, although they are somewhat stiff and mechanical when compared with designs founded on Nature in other styles.

Tracery is chiefly applied to stone and wood used in architecture; for galleries, windows, panels, etc., and for furniture.

Fig. **610** is the necessary construction for **611**, a design for a square panel; **612** shows three foliations for a circle; and **613** is the planning for a rose window, or for a circular panel.

Fig. **614** is the foundation for **615**, a curvilinear triangle, and **616** is a design for tracery for an equilateral triangular panel, suitable for woodwork or stone. In **617** is given the construction for **618**, the tracery which might be used for a window or a screen. Fig. **619** contains the foundation lines for **620**, a design for the head of a four-light window.

Many other beautiful examples of tracery can be found in good textbooks on Architecture.

ARCHES

The arch is a very ancient construction, and has appeared in many forms from the Classic periods. The Romans were the first to use the arch extensively in architecture, even if they were not the originators of this form. The earliest shape of the arch was semicircular [**621**], and this was in succeeding centuries changed to the various forms shown in **622** to **632**. The latter are only typical examples, which illustrate the arches in general use, and although the centres are shown from which the curves are struck, these centres, in most cases, may be varied in position.

The names of the individual parts of an arch are given in **621**.

Various Forms of Arches. The *segmental* arch may be struck from one centre as in **622**, or from two centres as in **623**. Fig. **624** is one form of the *horseshoe* or *Moorish* arch. The *equilateral* arch, much used in Gothic architecture in the thirteenth century, is shown in **625**. In the twelfth century the *lancet* arch [**626**] was very common, as also was the *obtuse* arch [**627**].

The *three-centred* arch given in **628** is constructed by first determining the height and the span; then make AC, BC, and DE, all equal. Join EC and bisect in F. The intersection C of the bisecting line FC with DE produced is the third centre. Describe arcs from C, C, C, as centres.

The *depressed Tudor* arch [**629**] is described from four centres. The *ogee* arch, or so-called ass's back, has either three [**630**] or four centres [**631**]. The *pointed trefoil* opening has the centres placed as shown in **632**. The parabola and ellipse may also be used for arch forms.

MOULDINGS

In architecture mouldings form a constituent part of an order, and were used in eight forms by the Romans and the Greeks. These forms are named: the *fillet*, a narrow, flat band used to separate and combine curved mouldings; the *astragal* or *bead*, a narrow or small convex cylindrical moulding [**634**]; the *torus* [**635**], which is really a large form of the astragal, and is often used at the base of columns; the *ovolo*, or *echinus* (meaning "egg-formed"), a convex moulding [**638** and **644**], which appears to have originated in the capital of the Doric column; the *cavetto* [**639** and **645**], which is the reverse of the ovolo; the *scotia* [**640** and **646**], a concave moulding which gives a deep shadow on itself and is very effective when used on bases of columns; the *cyma recta* [**641**, **642**, **647**, and **648**], a moulding with the concave above the convex portion; and the *cyma reversa* [**643** and **649**], which has the convex part uppermost.

Besides the above, the *chamfer* [**633**], the *reeds* [**637**], and the *flute*, a concave channel used to ornament the shaft of a column, are often used.

The characteristic difference between Greek and Roman moulding is that the former are described with parabolic, hyperbolic, and elliptical curves, and the latter with arcs of a circle; but the Greek are more graceful in contour.

The mouldings were often decorated with carving or colour, a particular design being used for each moulding, as in **638** and **649**.

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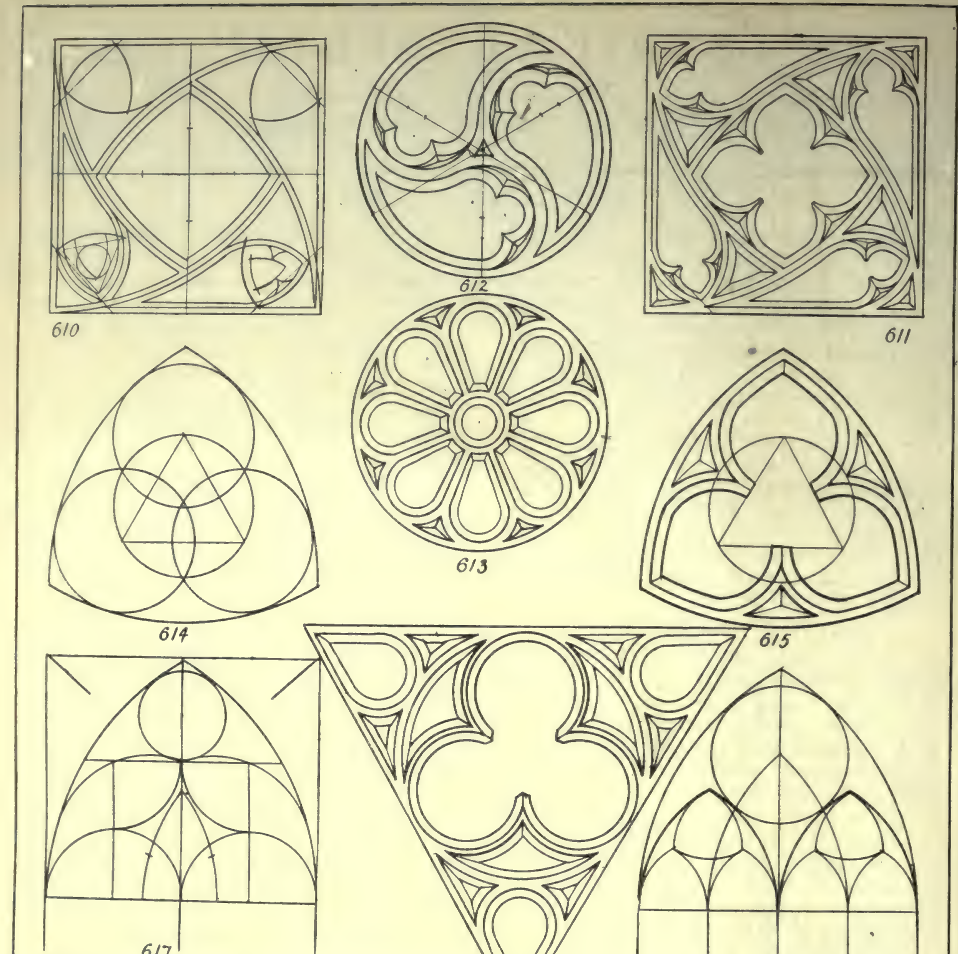
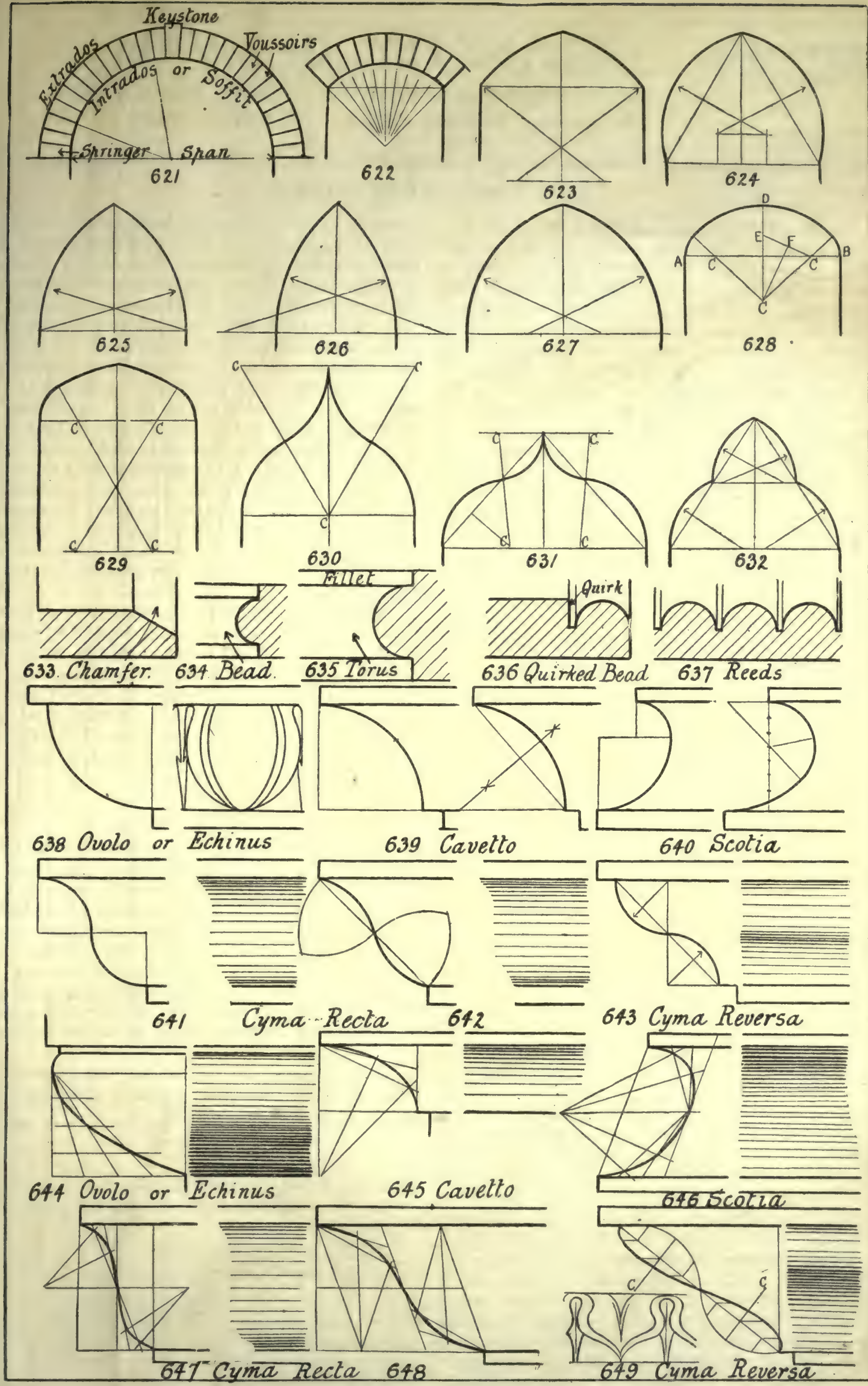


GOTHIC TRACERY



ARCHES AND MOULDINGS
Roman Mouldings, 638–643; Greek Mouldings, 644–649.

continued from page 2449

STABILITY OF WALLS

Stability Against Overturning and Crushing. Boundary Walls. Buttresses. Retaining Walls. Surcharged Walls. Dams

By Professor HENRY ADAMS

General Principles. The simplest case of the stability of a wall will occur when the wall is considered to overturn by pressure on one face without crushing the edge, which acts as a fulcrum. This can happen only when the total weight of the wall is very small. It is usual to consider one foot of the length of wall, as every foot will be similar, except in the case of walls with buttresses or counterforts. In **211** is shown the section of a wall, ABCD, of weight w per foot cube, height h, thickness t, total weight W, acted upon by a pressure p per square foot against one face, giving a total pressure P. Then $W = wht$, acting at the centre of gravity of the wall, and $P = ph$, acting at the centre of the height. Produce P through the centre of gravity of the wall and drop W from the same point, then find the resultant of the two forces by means of the parallelogram of forces. So long as the resultant cuts the base line within the wall, the wall will be in stable equilibrium; but should the resultant cut the base outside the wall, the wall will overturn. To find the maximum pressure per square foot for equilibrium,

$$\tfrac{1}{2}h : wht :: \tfrac{1}{2}t : ph,$$

whence,

$$ph = \frac{wht \times \frac{1}{2}t}{\frac{1}{2}h} = wt^2;$$

or,

$$p = \frac{wt^2}{h}.$$

From this equation it will be seen that the stability varies directly as the weight per cubic foot and as the square of the thickness, and inversely as the height. It must be observed also that the moments of the forces are equal—viz.,

$$P \times \tfrac{1}{2}h = W \times \tfrac{1}{2}t.$$

There is another possible mode of failure without crushing, and that is by pushing the wall off its base. This may happen if the wall is very thick compared with its height, and the pressure against the face is sufficiently great to cause the wall to slide without overturning. The coefficient of friction of fresh mortar may be taken as 0·5, so that when $P = \frac{1}{2}W$ and the resultant cuts the outer edge of base, the tendency to overturn or slide will be equal.

Distribution of Pressure on Base of Wall. A wall of rectangular section, built upright, and subject to its own weight only, produces a uniform pressure over the base, because the resultant meets it in the centre, as shown in **212**. The diagram at base of wall represents the ordinates of pressure. If a pressure acts against the wall horizontally at any point, the amount of total vertical load is not altered, but the resultant, or centre of pressure on the base, is pushed further over, causing an increase in the intensity on the outer edge and a reduction on the inner edge. If the horizontal pressure be sufficient to push the resultant over to the edge of the *middle third* of the base, as shown in **213**, the pressure will be increased to double at the outer edge and reduced to nothing at the inner edge. A wall under such conditions is generally considered to be absolutely safe, but it may not be really so, as the height, and consequently the weight, may be so great that doubling the pressure on the outer edge may produce a greater intensity than the material is capable of bearing. On the other hand, the resultant may pass beyond the middle third and the intensity of pressure still not be so great as to exceed the safe stress upon the material.

Resultant Beyond Middle Third. When the resultant passes beyond the middle third of the base, there are two cases to consider—one where the material will not bear any tension, and the other where tension may be allowed. Taking the former case, and assuming that the resultant passes at one-fourth the width of base from the outer edge, the maximum pressure in tons per square foot will be

$$p = \frac{2}{3} \cdot \frac{W}{d},$$

where W = total load in tons, and d = distance from resultant to outer edge in feet. Graphically, the triangle giving the ordinates of pressure will be carried back along the base twice the distance d from the resultant towards the inner edge, and the remainder of the base will be under no pressure, as in **214**. This formula is due to Professor Crofton, of the Royal Military Academy, Woolwich, and is generally accepted as giving a true result, although there are other possible views of the case.

When tension is permissible, the maximum pressure at outer edge and tension at inner edge are given by the formula

$$p = \frac{W}{A} \pm \frac{M}{Z},$$

where W is the vertical component of the resultant, A the sectional area of the base, M the bending moment—*i.e.*,

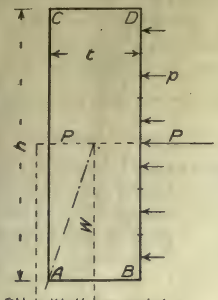
$$W(\tfrac{1}{2}t - d),$$

and Z the modulus of section—*i.e.*,

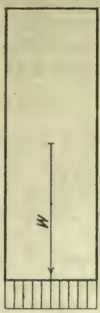
$$\tfrac{1}{6}(t \times 1^2) = \tfrac{1}{6}t;$$

the + value giving the intensity of the compression and the − value the intensity of the tension, as shown in **215**.

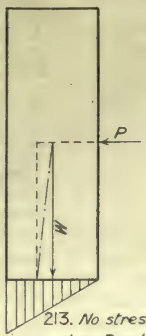
Boundary Walls. A boundary wall when newly built will come under the rule for **214**,



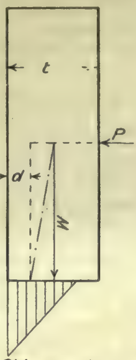
211. Wall on point of overturning.



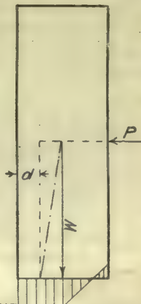
212. Base of wall under uniform pressure.



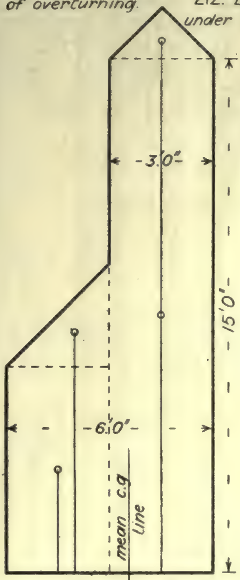
213. No stress on inner edge. Resultant at middle third.



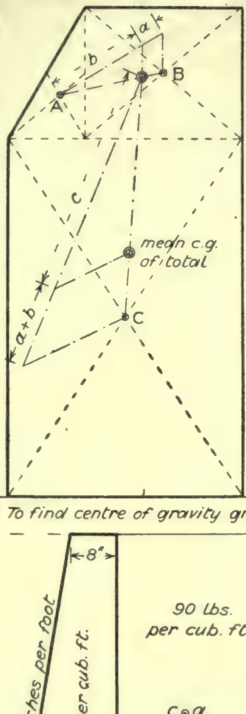
214. Resultant at one-fourth of base and no tension.



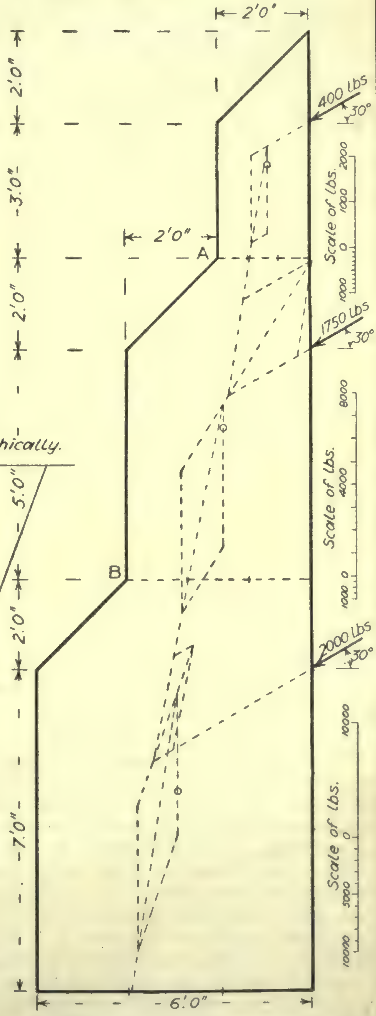
215. Resultant at one-fourth of base and tension allowed.



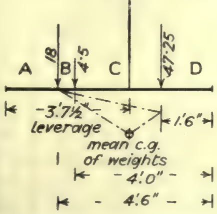
216. Elevation of buttress.



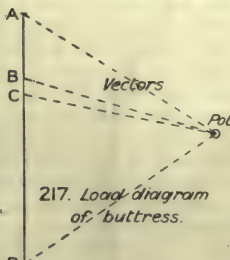
219. To find centre of gravity graphically.



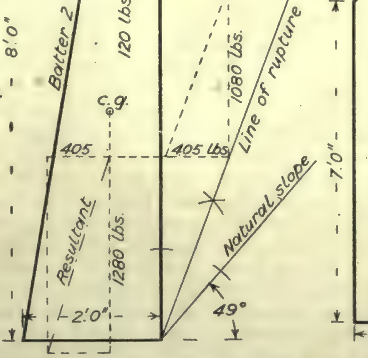
220. Buttress with thrusts.



218. Funicular polygon to give mean centre of gravity.



217. Load diagram of buttress.



221. Retaining wall for earth.

STABILITY OF WALLS AND BUTTRESSES

but when the mortar has set it will be to the rule for **215**. The safe proportions for thickness and heights of boundary walls are given in the following table.

SAFE PROPORTIONS FOR BOUNDARY WALLS.

9 in.	Up to	6 ft. 4½ in. high.
14 ,,	.. ,,	9 ft. 7½ in. ,,
18 ,,	.. ,,	13 ft. 0 in. ,,
23 ,,	.. ,,	16 ft. 6 in. ,,
27 ,,	.. ,,	20 ft. 4½ in. ,,

Stability of Buttresses. A buttress may be calculated as part of a wall, in which case the length is taken to include one buttress and the wall for half the distance towards the other buttresses on each side. This is, however, rather a troublesome calculation, and a buttress is often calculated by itself, especially when it is a large one to take the thrust of a roof truss, as with public halls and churches having hammer-beam trusses. The thrust upon each part of a buttress and the weight above the horizontal line for which the calculation of stability is made, are combined in a parallelogram of forces; but it will first be necessary to find the vertical line through the mean centre of gravity. This is most easily done by marking the centre of gravity of each part, as in **216**, and drawing force-lines through the points to meet the base. The weight of each part may be taken as acting through its centre of gravity to give the value of each force, and then, the load-line [**217**] being drawn, a pole is selected and vectors drawn from the points on the load-line to the pole. The force-lines in **216** may then be drawn down on to a separate line, like a beam [**218**], and the funicular polygon constructed by drawing lines parallel to the vectors, when the intersection of the closing lines A and D gives the position of the mean centre of gravity.

Another method of finding the mean centre of gravity of any number of separate parts is shown in **219**. First mark the centre of gravity of each part A, B, and C, then join A and B and at any angle draw a line upon which the weights of A and B are to be set off to scale in inverse order, as shown by *ba*, join the extremity with B, and at the junction of *a* and *b* draw a parallel line to cut AB at the mean centre of gravity. Join this with point C and repeat the operation as indicated, when the mean centre of gravity of the whole figure will be obtained. Applying these principles to an actual buttress [**220**] it will be necessary to ascertain the stability at each minimum section, thus, at A and B. Find the centre of gravity of the portion above A, and then of the part between A and B. Taking the part above A, first combine by parallelogram of forces the thrust and the weight to give the resultant shown, which is found to cut the base just within the middle third; then, producing this resultant, combine it with the next thrust to produce another resultant. It will be well to reduce the scale wherever necessary to prevent the parallelogram becoming unwieldy, as in this case. The last resultant will now be combined with the new weight and a new resultant will be found which also cuts the base just about the edge of middle third. This will show that the buttress is safe provided the intensity of the pressure be not too great. This pressure, with the resultant at edge of middle third, will be $= 2 \times \frac{W}{A}$, where W is the vertical component of the resultant and A the area of base.

Stability of Retaining Walls. A retaining wall is a wall of brick, stone, or concrete to hold up the earth at a change of level, as in a railway cutting through a town where there is not sufficient space available to allow of side slopes being formed. The pressure of the earth depends upon its *natural slope*—that is, the slope it would permanently retain if a bank of it were left exposed to the weather for an unlimited time. It may be taken generally as 30 degrees from the horizontal when the conditions are unknown, but the following table shows the natural slopes for ordinary soils as given by Rankine:

TABLE OF NATURAL SLOPES.

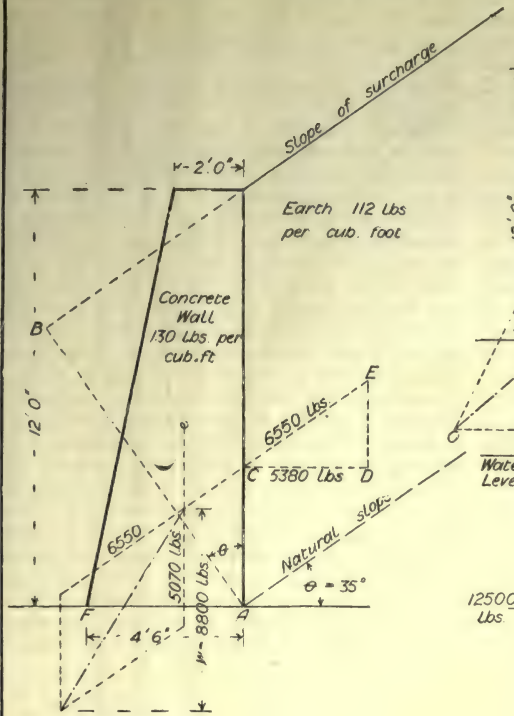
	Degrees.
Dry sand, clay and mixed earth ..	21 to 37
Damp clay	45
Wet clay	14 to 17
Shingle and gravel	35 to 48
Peat	14 to 45

This angle is sometimes called the *angle of repose*, but it means the same thing, as in the following table from "Notes in Building Construction," Vol. IV.:

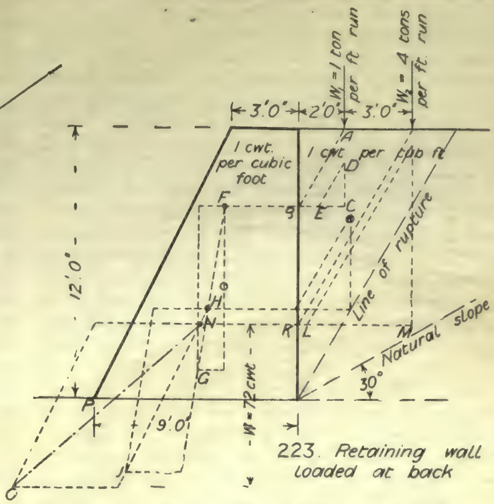
ANGLE OF REPOSE OF VARIOUS EARTHS.

	Degrees.
Fine dry sand	37 to 31
Sand, wet	26
Vegetable earth, dry	29
,, ,, moist	45 to 49
,, ,, very wet	17
,, ,, consolidated and dry	49
Loamy earth, consolidated and dry	40
Clay, dry	29
,, damp, well drained	45
,, wet	16
Gravel, clean	48
,, with sand	26
Loose shingle	39

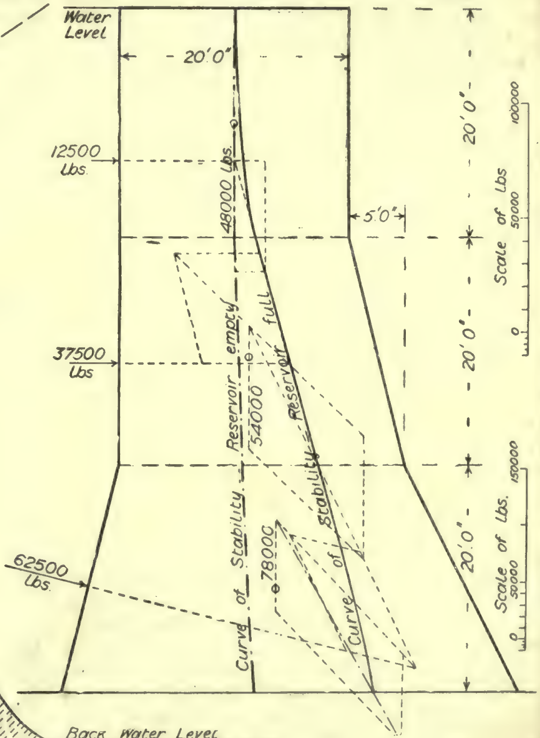
Everyone knows by personal experience that an overturning pressure may be most easily resisted by leaning against it, and the principle holds equally well with retaining walls. A wall to resist the pressure of earth will need less bulk in proportion as it can be leaned against the earth. The reason is that the centre of gravity is thrown further back, so that the weight of the wall acts with greater leverage. The usual form of section is shown in **221**, and the mode of working to ascertain the stability is indicated by the dotted lines. A given section has first to be assumed and then its stability determined. The line indicating the natural slope according to the material is put on at the back of the wall, starting at the level of the horizontal section where the stability is to be determined. Then the angle between the natural slope and the vertical is bisected to give



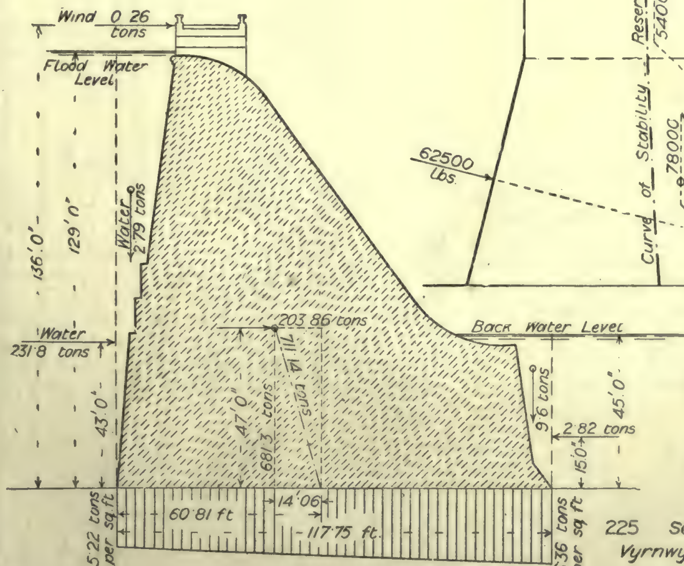
222 Surcharged retaining wall



223. Retaining wall loaded at back



224. Principle of calculating reservoir dam



225 Section of Vyrnwy dam.

SURCHARGED RETAINING WALLS AND RESERVOIR DAMS

the line of rupture; this may be considered as the line of fracture of the earth if the wall should overturn, or the primary angle at which the earth would stand unsupported, the natural slope being the ultimate angle after long exposure to the weather. The wedge of earth between the line of rupture and the back of the wall may be considered to press against the wall without friction. Its centre of gravity must be determined and its weight calculated, then, dropping a vertical line from the centre of gravity to meet the line of rupture, a length is measured upwards to any given scale to represent the weight of one foot run, and from the top of this measurement a line is drawn parallel to the line of rupture to cut a horizontal line from the junction with the line of rupture. The horizontal length so cut off gives the thrust upon the wall at one-third of the total height. Now, the centre of gravity of the wall must be found and the weight of one foot run calculated; then the thrust of earth and the weight of wall are combined by the parallelogram of forces to give a resultant, which in this case cuts the base at a distance of 0·416 ft. from the outer edge. By the formula $\frac{2}{3} \cdot \frac{W}{d}$ the maximum intensity of pressure upon the outer edge of base is found to be 0·9 ton per foot super.

Surcharged Retaining Wall. When the earth rises higher than the wall by reason of a sloping bank above it, the wall is said to be surcharged. Such a wall is shown in **222**, and the method of finding the thrust is as follows. Having drawn to scale the assumed section of wall and the earth at back, produce the line of slope of surcharge indefinitely through the wall, and from point A set out the angle θ equal to the natural slope of earth. Produce this line to cut the continuation of slope of surcharge in point B, then the horizontal thrust in pounds at point C, which is one-third the height of back of wall, will be $\frac{1}{2}w(AB)^2$, where $w =$ weight of earth in pounds per cubic foot, and AB = length in feet, then $\frac{1}{2} \times 112 \times 9{\cdot}8^2$ = say, 5,380 lb. set out as CD. Next, from D draw a vertical line and from C draw a line parallel to the natural slope to cut this vertical in point E, then CE will be the thrust on back of wall and will be found to equal about 6,550 lb. Producing this in the usual way and combining with weight of one foot length of wall, the resultant will be found to cut the base at a distance of 1·1 ft. from point F, then by the formula

$$\frac{2}{3} \cdot \frac{W}{d} = \frac{2 \times 8800}{3 \times 1{\cdot}1} = \text{say, } 5330 \text{ lb.},$$

or about 2·4 tons per square foot maximum compression on the wall.

Retaining Wall Loaded at Back. When a warehouse is built on the earth at the back of a retaining wall, or a large crane is fixed there, or a line of rails on a roadway runs near, the thrust upon the wall will be increased beyond that due to the weight of the wedge of earth. An approximate method of finding the thrust in such a case is shown in **223**. The difference from **221** is that an additional thrust due to the external load has to be combined with the ordinary thrust as follows: From the point of application A of the external load nearest the wall draw a line parallel with the line of rupture to cut the back of the wall in the point B, and from B set out BC horizontal, so that the point C is directly under the point A; next set up CD equal to the load on point A and make DE parallel with the line of rupture, then CE will be the amount of thrust due to load A acting on the back of wall at point B. Combining this with the weight of wall acting through its centre of gravity will give the first resultant, FG. Next, find the horizontal thrust due to the wedge of earth acting at one-third the height of back of wall and combine with FG, giving the second resultant, HJ. Then, treating the other load on the surface in exactly the same way as the load at point A, the horizontal thrust acting at point K will be LM, and combining this with the second resultant, HJ, the final resultant, NO, will be obtained, cutting the base of wall at a distance of 0·9 ft. from the toe P, when, by the formula

$$\frac{2}{3} \cdot \frac{W}{d} = \frac{2 \times 72}{3 \times 0{\cdot}9} = \frac{144}{2{\cdot}7} = 53{\cdot}3 \text{ cwt.},$$

or, say, 2·66 tons per square foot maximum compression on the brickwork.

Reservoir Wall or Dam. When a wall has to support the pressure of water the same method of working as in **221** might be adopted, taking the natural slope as zero; but it is more usual simply to calculate the pressure normal to the back of wall at one-third the height as $\frac{1}{2}wh^2$, where $w =$ 62·5 lb., the weight of a cubic foot of water, and h = the height of wall. For high walls the material is economised by using a curved batter, so that the resultant of thrust passes through the extremity of the middle third at every horizontal section. A dam is shown in **224** in three simple stages to illustrate the mode of working to ascertain the stability. For a plain wall with straight batter the thickness at base may be approximately seven-tenths of the height. The section of the Vyrnwy dam is shown in **225**, with particulars of the loads and thrusts. This is of special interest owing to its magnitude and the successful manner in which the whole of the works were executed.

Continued

OFFICE-KEEPERS AND BOYS

Messengers, Office-keepers, Housekeepers and Attendants.
Boy Clerks and Messengers: Examination and Remuneration

NATIONAL SERVICE
continued from page 2474

By ERNEST A. CARR

POSTS as messenger, office-keeper, housekeeper, and attendant are usually filled without competition by candidates who obtain the requisite official nomination. The right to nominate is generally vested in the head of each department; but in some instances it is in the hands of the Lords of the Treasury. The limits of age for these appointments are 21 and 35, but candidates who have served in the Army or Navy, the Metropolitan Police or the Royal Irish Constabulary, are allowed to deduct such service in reckoning their age. When a vacancy arises in a department, the person nominated has only, as a rule, to pass a qualifying examination of an elementary character before receiving the appointment. Occasionally, however, two or three men compete for a single vacancy. The subjects of examination are writing (with copying manuscript), spelling, and arithmetic, comprising the first four rules, money and avoirdupois weight.

Although a certain amount of influence, direct or indirect, is almost indispensable for securing a situation of this class, it is by no means necessary that the applicant should be personally known to the official who has the right to nominate. Character, ability, and a good record are as least as important. Satisfactory service in the Army or Navy is always a strong recommendation to the nominating authority. During the last year on the records, out of 290 vacancies for messengers in various Government offices, no fewer than 122 were filled by ex-soldiers and ex-sailors.

Rates of Pay. The salaries of subordinate officers vary a good deal, and in certain instances are augmented by "perquisites" whose value is a jealously guarded secret. The following rates may, however, be regarded as typical. Messengers and attendants commence at a figure between £65 and £80, and rise by small increments to £100, £120, or (for chief posts) £150 to £200 a year. They have also chances of advancement to the grade of office-keeper, with a salary of £100 or £150, an official residence, coal and lights, and other allowances on a liberal scale. Door-keepers are similarly remunerated as a rule, but in important positions (as in the Houses of Parliament) they receive from £250 to £300 a year.

BOY CLERKSHIPS

The position of boy clerk in the public service is a purely temporary one, carrying no claim to superannuation, and coming to an end when the age of twenty is reached. Nevertheless, this is in several respects a distinctly useful way of gaining a footing in the service, and, considering the overcrowded state of the commercial labour market, it is surprising to find that in recent years the number of qualified candidates has not always been equal to the demand, and that very moderate marks are needed for success at any of the competitions for appointments.

We have already referred to some of the advantages afforded to boy clerks when competing for the higher posts. Not only in the examinations for Second Division clerkships, but also in those for port service clerks and assistants of Customs and Excise, they may claim both service marks and a deduction from their actual age, even though at the time of the examination they are no longer in the service. For the Excise competitions this allowance is one year, and in the other cases two years. With such aids to success, a lad of ordinary ability and energy can scarcely fail to obtain a good permanent appointment, and at the worst an assistant clerkship is not altogether to be despised.

Competitions open to boys between 15 and 17 years of age are held about thrice yearly, a batch of some two or three hundred candidates being selected on the results of each. For the convenience of competitors, the examinations are held simultaneously at a number of centres—usually in London, Edinburgh, Dublin, Bedford, Bristol, Liverpool, Southampton, Aberdeen, Glasgow, Belfast, and Cork. A fee of 5s. is payable by each candidate.

Particulars of the subjects are furnished by the accompanying table. It relates to an examination recently attended by 800 contestants, 261 of whom were placed on the register of boy clerks and given employment as occasion arose.

EXAMINATION FOR BOY CLERKSHIPS

					Any two may be taken.							
							Translation from					
Order of Merit.	Handwriting and Orthography.	Arithmetic.	English Composition.	Copying Manuscript.	Geography.	English History.	Latin.	French.	German.	Mathematics	Chemistry and Physics (rudiments).	Total.
Max.	400	400	400	200	400	400	400	400	400	400	400	2,200
1	363	346	340	188	326	—	—	335	—	—	—	1,898
261	355	256	202	125	338	—	—	—	—	75	—	1,351

Examination Subjects. The papers set at this competition were typical of their class. The exercise in copying manuscript was long but fairly easy. Candidates were given two simple passages of about equal length to be transcribed in three-quarters of an hour, all abbreviations having to be written out at full length, and the punctuation corrected where necessary. The test in orthography was a curious one, consisting of a fable taken from some ancient work and preserving the antique mode of spelling. We quote a typical portion of the story: "The fellowe that profest him friendeshippe, tooke to his feete and ranne and climmed up to the top of a hye tree. The straunger perceyving that his friende was fledde, and he himselfe not able to escape, fell downe unto the grounde; for it is sayde that the Lion and the Beare will spare their yeelded praies, and specially the Beare, if a man hold hys breth as though he were deade." Of this narrative a copy had to be made, putting all the words into modern spelling, but making no other changes.

The exercise in English composition comprised, in addition to a short essay, the perusal of a long passage in prose and verse—the adventure of Childe Rowland with the King of Elfland—which each candidate had then to narrate in substance in his own words, and as far as possible in his own way. The arithmetic paper included the following curious test of each candidate's ability to use a rule, as well as his grasp of mathematical principles: "Measure in centimetres the length and diameter of the block supplied. If the length of such a block is l cm. and the diameter d cm., it is known that the volume is $0{\cdot}79 \times l \times d \times d$ cubic centimetres. Use this to find the volume of the block."

It is necessary only to add that the mathematics paper in these contests comprises Euclid, Books I. and II., and algebra up to simple equations, and that no subjects are obligatory, but that a qualifying total of half the maximum marks must be obtained. In the contest to which our table relates, 544 candidates reached that standard, being in the proportion of only about two qualified competitors for each place.

Pay and Conditions of Service. Boy clerks are usually engaged for 39 hours weekly, and are paid during their first year 15s. a week, 16s. the next, and so up to the maximum of 19s. Overtime work is paid for at corresponding rates. Sometimes they are employed and paid by the hour instead, the rate being 4½d. per hour during the first year, and advancing yearly by a halfpenny per hour to 6d. As a little calculation shows, under this system of payment the net result is practically the same as under the weekly scale. In either case continual service is not officially guaranteed. The method of employment, according to the regulations, is as follows. A register of boy clerks is kept by the Civil Service Commissioners, and candidates declared successful at the competitions have their names placed upon it. As vacancies for boy clerks arise in the various public departments, those who are on the register are summoned to attend for duty, on the understanding that the work may prove only temporary, and that they will not be paid except while actually engaged by the department. As a matter of practice, however, the great majority of boy clerks are regularly employed. They are almost always called upon to serve in London, but recently a separate register has been instituted for appointments in Ireland, and at the last examination 20 vacancies were announced as Irish.

Boy clerks, when employed, are paid for all public holidays, as well as during the fortnight's annual leave to which they are entitled if permanently on duty. Sick leave, up to a certain maximum, is granted on three-fourths of full pay. In case of enforced absence, owing to infectious disease in the boy clerk's residence, he may be given the full rate of pay during his absence.

Prospects for Boy Clerks. As an incentive to him in preparing for the examinations admitting to permanent appointments in the service, there is a further and valuable provision that a boy clerk who obtains leave from the head of his department in order to attend an open competition for Second Division clerkships, or for assistant clerkships, may receive full pay while attending the contest.

In view of the advantages already discussed and the useful training in Civil Service subjects which these examinations afford, a youth who must earn his own living and has his way to make in the service could scarcely make a better start than in the modest capacity of a boy clerk. And unless he is sadly wanting in ability and application, he should not find the least difficulty in obtaining an appointment, there being —as we have shown—no serious competition for such posts.

BOY MESSENGERS

A register of temporary boy messengers for employment in Government offices is kept by the Civil Service Commissioners, and lads of good health and character, between 14 and 16 years of age, who have passed Standard V. in an elementary school or can pass a test in reading and writing, may apply to be registered. They are then eligible for service as occasion arises, and while employed are paid 9s. a week, rising by 1s. 6d. a week for each year's service up to the age of 20, when their names are removed from the register. As well-paid work of a light and pleasant nature, boy messengerships are in considerable request, and from time to time it becomes necessary to suspend registration for a while until employment has been found for the lads already on the register.

Continued

ALGEBRAIC EQUATIONS

Problems Leading to Simple Equations with One Unknown Quantity. Problems Leading to Simple Simultaneous Equations

continued from page 2384

By HERBERT J. ALLPORT, M.A.

PROBLEMS LEADING TO SIMPLE EQUATIONS

51. By the aid of Algebra we are able to solve problems the solutions of which by Arithmetic are either impossible or very laborious. We have simply to express the conditions of the question in algebraical symbols. This gives us one or more equations, the roots of these equations being the unknown quantities which the problem requires us to find.

We shall first consider problems in which there is only *one* unknown quantity, and in which the conditions of the question lead to a simple equation—*i.e.*, an equation of the first degree.

Example **1.** The difference between two numbers is 5; if 2 be added to the greater, the result is twice the smaller. Find the numbers.

Here, although we have to find *two* numbers, we may still consider the problem as containing only *one* unknown quantity. For, if we can find, say, the greater of the two numbers, we obtain the other by subtracting 5. Suppose, then, that

$$x = \text{the greater number.}$$

It follows that

$$x - 5 = \text{the less number.}$$

Now, the question tells us that if we add 2 to the greater number, the result is twice the less.

But, by adding 2 to the greater number we obtain $x + 2$, and twice the less number is $2(x-5)$.

Hence we have the equation

$$x + 2 = 2(x-5).$$

Removing the brackets, and transposing the terms, we get

$$2x - x = 2 + 10$$

or,

$$x = 12.$$

Thus, the greater of the two numbers is 12, and the other number is $x - 5$, *i.e.*, $12 - 5$, or 7.

Example **2.** The sum of £8 12s. 6d. is paid with 30 coins, some of which are half-crowns, and the rest are half-sovereigns. How many are there of each sort?

Let $x =$ the *number* of half-crowns.

Then, since there are 30 coins altogether, the number of half-sovereigns must be $30 - x$.

We have now to express algebraically the fact that x half-crowns and $(30-x)$ half-sovereigns make a total of £8 12s. 6d. We must be careful in forming our equation that all the quantities involved are expressed in terms of the same unit. In this particular case it is convenient to work in half-crowns.

We know that a half-sovereign equals 4 half-crowns.

Therefore,

$(30-x)$ half-sovereigns equal $4(30-x)$ half-crowns.

Also, £8 12s. 6d. equals 69 half-crowns. We have, then, simply to write down the statement algebraically that x half-crowns and $4(30-x)$ half-crowns make 69 half-crowns. Thus

$$x + 4(30-x) = 69.$$

Solving this equation in the ordinary way, we find that $x = 17$, and therefore $30 - x = 30 - 17 = 13$. Thus the solution of the problem is that there are 17 half-crowns and 13 half-sovereigns.

Example **3.** A has as many florins as B has half-crowns. If B gives A two of his half-crowns they will then have equal amounts of money. How much had each at first?

Let $x =$ the *number of coins* each has at first. When B has given A two half-crowns, B will have $(x-2)$ half-crowns, and A will have x florins + 2 half-crowns.

Expressing the values in sixpences, we see that B has $5(x-2)$ sixpences (for 5 sixpences make half-a-crown), and A has $(4x+10)$ sixpences.

Hence,

$$5(x-2) = 4x + 10.$$

The solution of this equation is

$$x = 20.$$

Therefore,

A had 20 florins, or £2,
B had 20 half-crowns, or £2 10s.

Example **4.** A man's age is 38, his son's is 16. When was the father 3 times as old as the son?

Let $x =$ number of years which have passed since the father was 3 times as old as the son.

Then, x years ago the father's age was $38 - x$, and the son's was $16 - x$, so that

$$38 - x = 3(16 - x).$$

This gives $x = 5$, so that the required solution is, 5 years ago.

Example **5.** A number consists of two digits whose sum is 9. If the digits be interchanged, the number so formed exceeds the original number by 45. Find the number.

Let $x =$ the digit in the units' place.

Then, since the sum of the digits is 9,

$$9 - x = \text{the digit in the tens' place.}$$

Probably, the beginner's only difficulty will be in writing down the number. But he has only to think of the meaning of a number expressed in the ordinary notation.

The number 37, for example, means 3 tens + 7 units. In the same way, then, if $(9-x)$ stands for the tens' digit, and x for the units' digit, the value of the number is

$$(9-x) \text{ tens} + x \text{ units}$$

i.e.,

$$10\,(9-x)+x.$$

Similarly, if the digits are interchanged, the number obtained will be

$$10x+(9-x).$$

The question tells us that the second of these exceeds the first by 45.

Hence,

$$\{10x+(9-x)\}-\{10\,(9-x)+x\}=45.$$

Solving this equation, we obtain $x=7$. Thus, the units' digit is 7, and the tens' digit is $9-7$, *i.e* , 2. The required number is, therefore, 27.

EXAMPLES 9

1. Find two numbers whose sum is 63 and whose difference is 7.

2. Find the number which, when multiplied by 3, is as much above 18 as it was originally below 18.

3. Divide 39 into two parts such that twice one part is 2 less than three times the other.

4. Divide 69 into three parts such that the first shall be double the second, and the second be 3 more than thrice the third. [Let $x=$ the third part.]

5. Find a number such that the product of one more than its double and one less than its half may be 10 less than its square.

6. A father's age is three times his son's age. In 12 years the father will be twice as old as the son. What are their present ages ?

7. The united ages of three sisters make 47. The youngest is 3 years younger than the second, and the second is 5 years younger than the eldest. How old are they ?

8. A sum of money is divided between A, B, and C, so that A and B have £39 between them, B and C have £26, and A and C have £31. Find the amount each has.

9. There are 81 coins, of which some are crowns and the rest are shillings. If the crowns were florins and the shillings were half-crowns, the total value would be unaltered. Find the number of coins of each sort.

10. If 12 oranges cost as much over 10d. as 20 cost under half-a-crown, how many oranges can be bought for five shillings ?

11. Of two squares of carpet, one measures 16 feet further round than the other, and contains 64 square feet more in its area. Find the length of the side of each square.

12. A purse contains 26 coins, whose total value is £6. A certain number of the coins are sovereigns, there are three times as many half-crowns, and the rest are shillings. How many coins are there of each sort ?

13. If A gave B ten shillings he would have three times as much as B ; while if B gave A five shillings, A would have four times as much as B. How much has each ?

14. Find three consecutive numbers whose continued product is 5 less than the cube of the middle number.

15. A number of two digits is such that one digit is three times the other, and if the digits be interchanged the number so formed exceeds twice the original number by 10. Find the number.

PROBLEMS WITH TWO UNKNOWN QUANTITIES

52. We will now consider problems with *two* unknown quantities involved. Many of the questions already given did, as we saw, contain two unknown quantities, but they were of such a nature as enabled us to form an equation containing only *one* unknown. Even when this is possible the work is often simplified if we take two unknowns, and from the conditions of the question form two equations.

Example **1.** 6 lb. of tea and 8 lb. of sugar cost 11s. 2d., and 5 lb. of tea and 2 lb. of sugar cost 8s. 4d. ; find the cost of each per lb

Let

$x=$ cost of 1 lb. of tea, *in pence*

and

$y=$ cost of 1 lb. of sugar, *in pence.*

[NOTE. Always be careful to state exactly what the unknown quantities x and y are intended to represent. They will, of course, always stand for *numbers*, but it must be made clear whether it is a number of *pence*, or *shillings*, or *miles*, as the case may be. Such a statement as "Let $x=$ price of 1 lb. of tea" is much too vague.]

Therefore 6 lb. of tea cost $6x$ pence, and 8 lb. of sugar cost $8y$ pence. The total cost is thus $(6x+8y)$ pence. But the question tells us that the cost is 11s. 2d., or 134 pence. Hence,

$$6x+8y=134. \quad . \quad . \quad . \quad (1)$$

In the same way, since 5 lb. of tea and 2 lb. of sugar cost 8s. 4d., we have

$$5x+2y=100. \quad . \quad . \quad . \quad (2)$$

By solving (1) and (2) we obtain

$$x=19,\ y=2\tfrac{1}{2}.$$

Thus, 1 lb. of tea costs 19d., or 1s. 7d., and 1 lb. of sugar costs $2\frac{1}{2}$d.

The above problem is an example in which, although it is not *necessary* to use two unknown quantities, the work is simpler if we do so. Using only one unknown, the problem would be solved as follows :

Let

$x=$ cost of 1 lb. of tea, in pence ;

then $6x$ pence $=$ cost of 6 lb.

But 6 lb. of tea and 8 lb. of sugar cost 134d.

Therefore 8 lb. of sugar cost $(134-6x)$ pence ; or,

$$\frac{134-6x}{8}=\text{cost, in pence, of 1 lb. of sugar.}$$

Hence, since 5 lb. of tea and 2 lb. of sugar cost 100 pence, we have

$$5x+\frac{2\,(134-6x)}{8}=100.$$

The solution of this gives $x=19$. The cost of the sugar is then obtained by substituting the value of x in the expression

$$\frac{134-6x}{8}.$$

Example **2**. The wages of 7 men and 11 boys for a day amount to £2 1s., and 2 men receive 6d. less than 5 boys. Find the daily wages of a man.

Let

$x =$ number of shillings a man earns per day,

and

$y =$ number of shillings a boy earns.

Then 7 men and 11 boys will earn $(7x + 11y)$ shillings.

Therefore,

$$7x + 11y = 41. \quad . \quad . \quad . \quad (1)$$

Again, $2x$, the amount earned by 2 men, is 6d. less than $5y$, the amount 5 boys earn; so that $2x$ shillings and $\frac{1}{2}$ shilling make $5y$ shillings.

Therefore,

$$2x + \tfrac{1}{2} = 5y. \quad . \quad . \quad . \quad . \quad (2)$$

Clearing (2) of fractions, and transposing, we have

$$4x - 10y = -1. \quad . \quad . \quad . \quad (3)$$

Multiply (1) by 10 and (3) by 11, and add. Then

$$70x + 44x = 410 - 11;$$

or,

$$114x = 399.$$

Therefore,

$$x = 3\tfrac{57}{114} = 3\tfrac{1}{2} \text{ shillings}.$$

Hence, a man's daily wage is 3s. 6d. *Ans.*

Example **3**. A has three times as many shillings as pennies, and B has three times as many pennies as shillings. If A has 7d. more than B, and together they have two more pennies than they have shillings, how much has each?

Let

$x =$ number of pennies A has;

then

$3x =$ number of shillings A has.

Similarly, if

$y =$ number of shillings B has,

then

$3y =$ number of pennies B has.

We obtain one equation from the fact that, together, they have 2 more pennies than shillings. Thus,

Total number of pennies $= x + 3y$,

and,

total number of shillings $= 3x + y$.

Therefore,

$$x + 3y = 3x + y + 2;$$

or, transposing, and dividing by 2,

$$x - y = -1. \quad . \quad . \quad . \quad . \quad . \quad (1)$$

We obtain the second equation from the *values* of the sums of money A and B have. Thus, A has x pennies and $3x$ shillings, that is $(x + 36x)$ pence, in value. Similarly, B has $(12y + 3y)$ pence, in value. Hence,

$$x + 36x = 12y + 3y + 7;$$

or,

$$37x - 15y = 7. \quad . \quad . \quad . \quad (2)$$

Multiply (1) by 15 and subtract from (2). Then

$$37x - 15x = 7 + 15;$$

or,

$$22x = 22.$$

Therefore,

$$x = 1.$$

Hence A has 1 penny, and, consequently, 3 shillings. His total is thus 3s. 1d. This, the question tells us, is 7 pence more than B has, so that B's total is 2s. 6d.

Example **4**. A number of three digits has its tens' digit double of the units' digit. It exceeds by 99 the number formed by reading the digits backwards, and the sum of these two numbers is 585. Find the original number.

Let

$x =$ digit in the units' place;

then

$2x =$ digit in the tens' place.

Let

$y =$ digit in the hundreds' place.

Then the number is $100y + 20x + x$. [Compare Art. **51**, Ex. **5**.] If the digits are read backwards, x becomes the hundreds' digit, $2x$ the tens' digit, and y the units' digit. The number is then $100x + 20x + y$. Hence,

$$(100y + 20x + x) - (100x + 20x + y) = 99; \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and

$$(100y + 20x + x) + (100x + 20x + y) = 585. \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Collecting terms, we get from (1)

$$99y - 99x = 99;$$

or,

$$y - x = 1. \quad . \quad . \quad . \quad . \quad (3)$$

and, from (2)

$$141x + 101y = 585. \quad . \quad . \quad . \quad (4)$$

Solving (3) and (4) we find $x = 2$, $y = 3$.

Hence, the units' digit is 2, the tens' digit is twice 2, and the hundreds' digit is 3.

The required number is thus 342 *Ans.*

EXAMPLES 10

1. Find two numbers such that their sum is less by 2 than five times their difference, and three times the greater exceeds four times the less by 7.

2. In another year a father will be four times as old as his son; 2 years ago he was three times as old as his son will be in another 3 years. Find their present ages.

3. A number of two digits exceeds 5 times the sum of the digits by 7, and exceeds by 9 the number formed by reversing the digits. Find the number.

4. A, B, C, and D have £100 amongst them. C has twice as much as A, and B has three times as much as D. Also, C and D together have £2 10s. more than B. How much has each?

5. In 2 years' time a father will be three times as old as his elder son, and five times as old as his younger son. In 23 years' time his age will be equal to the sum of his sons' ages. How old is each of them now?

6. In 8 hours A walks 8 miles more than B does in 5 hours, and in 9 hours B walks a mile

more than A does in 10. How many miles does each walk in an hour?

7. A and B have a guinea between them. If A gives B a shilling for every penny B has, A will have 5s. less than B. How much has each at first?

8. A takes 5 hours more than B to go a distance of 60 miles. If A had doubled his pace he would have taken 5 hours less than B. Find the rate at which each travelled.

Answers to Algebra

Examples 7

1. $x = 2$. 2. $x = -\frac{1}{4}$. 3. $x = 12$.

4. Multiply both sides by 6, obtaining $3x - 6 - 2x - 8 = 5x - 2$, whence $x = -3$.

5. $3(x^2 + 2x + 1) + 4(x^2 - 6x + 9) = 7(x^2 - 2x + 1)$.

Therefore,

$$6x - 24x + 14x = -3 - 36 + 7;$$

giving

$$x = 8.$$

6. Multiply by 12. Then $6(x + \frac{1}{4}) - 3(3x - \frac{1}{4}) = 4(x - \frac{3}{4})$, so that $6x - 9x - 4x = -3 - \frac{3}{4} - \frac{6}{4}$. Therefore $-7x = -\frac{21}{4}$ and $x = \frac{3}{4}$.

7. $x = 1$.

8. $(x + a + x + b)(x + a - x - b) = (a - b)^2$ [Art. **34**], or $(2x + a + b)(a - b) = (a - b)^2$. Divide both sides by $(a - b)$. Then $2x + a + b = a - b$. Whence $x = -b$.

9. Multiply both sides by x. Then $a + b = cx(a + b)$. Divide both sides by $(a + b)$, and we get $1 = cx$, or $x = \frac{1}{c}$.

10. Removing brackets [Arts. **33** and **31**] we have

$$\begin{aligned} &x^3 + 3ax^2 + 3a^2x + a^3 \\ &+ x^3 + 3bx^2 + 3b^2x + b^3 \\ &+ x^3 + 3cx^2 + 3c^2x + c^3 = 3x^3 + 3x^2(a + b + c) \\ &\qquad + 3x(bc + ca + ab) + 3abc. \end{aligned}$$

Collecting terms, $3x(a^2 + b^2 + c^2 - bc - ca - ab) = -(a^3 + b^3 + c^3 - 3abc)$.

Divide both sides by $3(a^2 + b^2 + c^2 - bc - ca - ab)$ [Art. **42**, Ex. **2**] and we get

$$x = \tfrac{1}{3}(a + b + c).$$

Examples 8

1. $x = 5$, $y = 3$. 4. $x = 3\frac{3}{8}$, $y = \frac{3}{4}$.
2. $x = 3$, $y = -4$. 5. $x = y = 5$.
3. $x = 3$, $y = 2$. 6. $x = 4$, $y = 8$.

7. Since $\frac{x}{15} + \frac{y}{12} = 1$, we have $4x + 5y = 60$. And since $\frac{x}{3} - \frac{y}{4} = 1$, we have $4x - 3y = 12$. Hence, $x = 7\frac{1}{2}$, $y = 6$.

8. Multiply first equation by 10, giving $5x - 5y - 6x + y = 5$, or $x + 4y = -5$. Multiply second equation by 6, $2x - 3y = 12$. Hence, $x = 3$, $y = -2$.

9. Solve for $\frac{1}{x}$ and $\frac{1}{y}$, obtaining $\frac{1}{x} = \frac{1}{2}$, $\frac{1}{y} = -1$. So that $x = 2$, $y = -1$.

10. Solve for x and $\frac{1}{y}$. Solution is $x = 4$, $y = 1$.

11. $x = y = a - b$. 12. $x = a$, $y = b$.

13. Add the three equations together, $2x + 2y + 2z = 20$. Therefore, $x + y + z = 10$. Subtract each equation in turn from this, and we obtain $x = 3$, $y = 5$, $z = 2$.

14. $x = -3$, $y = 1$, $z = 3$.

15. Add first two equations, giving $\frac{2}{x} = 4$. Hence, $x = \frac{1}{2}$. Substitute in second and third equations, and we get $\frac{1}{y} - \frac{1}{z} = -2$, and $\frac{1}{y} + \frac{1}{z} = 10$. Whence $y = \frac{1}{4}$, $z = \frac{1}{6}$.

Note. The answer to Algebra Examples 2, No. 5 [page 1994], should read "$-2ab$," etc.

Continued

PROSPECTING AND BORING

Searching for Minerals. The Discovery of Hidden Deposits. Electric Ore Finding. Boring and Blasting Tools and Practice

Continued from page 2380

By D. A. LOUIS

THOSE who go in search of minerals, or, as it is called, *prospecting*, frequently go with a definite idea of looking for some special mineral for which a district has already some reputation. For instance, the Transvaal, the West Coast of Africa, Western Australia, would be prospected for gold; diamonds would be sought for in South Africa, Brazil, and India; the Ural Mountains for various minerals, including platinum. And in any region where active operations were in progress as much information as possible would be gleaned from the other workings, from maps and from published records—such, for instance, as those of our own Geological Survey—before undertaking fresh explorations. But any country, especially a new country, should be visited with an open mind and a keen outlook for the occurrence of any minerals that could be turned to good account, and their character should be carefully recorded.

Prospecting Possibilities. A noteworthy feature in the utilisation of mineral deposits is the element of uncertainty. A mineral of great value at one time may be of little value at another period. For example, silver mines in which the writer worked and which paid well in '87 will not pay now. Again, when he was working in Cornwall wolfram was a useless, troublesome constituent that was thrown away; now the requirements of commerce create a demand for it, and special works are profitably employed in Cornwall in extracting it. Once, a single mine working part of the year was sufficient to cover the world's requirements of pitch-blende; now it is eagerly sought for as a source of radium. Monazite was simply regarded as a scientific curiosity until Auer von Welsbach introduced the incandescent gas mantle made from some of its constituents, so that monazite sands are now extensively worked. Phosphatic fluxes, once scorned, are now in demand for iron smelting so as to produce a slag rich in phosphorus for use in agriculture.

When prospecting, the general aspect of the country, its water supply, its timber, and its geological character should first be observed most carefully.

An igneous country may be examined for basalts, granites, and such deposits, but it is useless to look for coal or any other stratified mineral deposit in such a neighbourhood. In a metamorphic country, all sorts of metallic treasures and many kinds of precious and ornamental stones may be expected, but, again, no coal or ordinary stratified deposits. In a stratified country, on the other hand, igneous rocks may occur, as, for instance, the bosses of crystalline rocks in Leicestershire, which project through Triassic strata; metamorphic rocks are likewise occasionally encountered in stratified regions.

Stratified Country. In a stratified country the order of superposition and the character of the rocks should be ascertained by inspecting any exposures and identifying any fossils; in this way the geological age of the deposit can be determined, and its possibilities of yielding mineral treasure predicted with some degree of certainty. Thus, if the exposures were Devonian in character, building stones, paving stones, and slates might be looked for. It would, however, be useless to search for Portland stone, or Bath stone, or coal in them or below them. With Lias beds exposed we might encounter hydraulic limestones, building stones, and below them coal, and so on.

Other observations should be made simultaneously, such as any pronounced colour of the soil or any staining of the rocks. Blackness might indicate coal or manganese; greens and blues, copper; ochreous patches, iron; red, iron, or even cinnabar; and so on. Vegetation should be noted, as some plants are addicted to certain kinds of rock; moreover, the presence of certain minerals in an otherwise fertile soil will cause sterility and vice versâ, so if change of vegetation or an area of barrenness be observed the cause should be investigated.

Ploughing and Animal Burrowing. Material thrown up by burrowing animals or exposed in digging or ploughing, and, of course, railway cuttings or any excavations, should be most carefully examined for the presence or indications of useful minerals. Fallen stones, especially those carried down by rivers, should be carefully inspected, and if any stones of a promising character, such as vein-rock, which are known as *shodes* or *shoad stones* be found, the inspection should be continued up the valley or river, and ultimately the source from which the stones have been derived may be found and a mineral vein discovered. This may be miles or only a few feet away.

From the prospector's points of view, a satisfactory feature about veins is that the vein-rock is generally of a different degree of hardness to the surrounding rock; usually it is harder, but occasionally it is softer, hence it is that, in weathering, the outcrop is marked by projecting masses of rock, or more rarely by depressions, which may generally be followed by the eye away across the country indicating the strike of the vein. These outcrops must be scrutinised most earnestly to see if they contain any useful minerals or indications of them. Should the

outcrop have the appearance of a cellular, cindery, spongy-looking mass, deeply stained with dark and other hues of brown, it is the material known as *gossan*, and is generally a favourable indication.

In stratified deposits variable hardness is also indicated by the weathering; if hard, the exposed edge of more or less horizontal beds will form a steep face or *escarpment;* while, if soft, the face will be sloping. If the beds are more or less tilted, as they frequently are, then the softer beds will form the depressions, and the harder beds the projections and hills in the landscape. It often happens that patches of soft beds protected by resisting deposits remain as mounds, or even form earth pillars.

Discovering Hidden Deposits. It very frequently happens that the useful deposits of minerals are hidden from view. To discover them various practices are adopted. The position of any springs are noted and the character of the water investigated. Any mounds or heaps become the objects of particular solicitude, as they may prove to be the waste material from old mining and smelting operations, and an examination of the material would give useful information concerning the character of any deposit in the neighbourhood.

Probing. Probing is a simple means of search for shallow deposits; it consists simply of thrusting a sharp-pointed steel rod or wooden stick shod with iron or steel into the ground, and if the mineral sought be harder or softer than the surrounding soil its presence is detected by the feel. The position of shallow deposits of strontium mineral in Gloucestershire, of burr-stones in France, and of phosphates in Carolina are disclosed in this way. The end of the rod may be examined for adhering mineral in the case of a deposit that could not be detected by the feel alone.

Hushing. Hushing is a method by which water is used to scour off the covering soil, and so expose any underlying, solid, hard deposit to view; the water for the purpose is collected in a reservoir, and directed by channels to the ground to be hushed.

Magnetic Search. In the case of deposits that affect a magnet, this instrument is used to indicate its presence. For this purpose both the ordinary compass and dipping needle are used. The deflections are noted, and from their intensity and direction large masses of buried iron ore have been discovered.

Electric Ore Finding. Electric ore finding has recently been introduced to aid in the discovery of useful mineral deposits. The system is based on the discovery made by Sir William Preece about 20 years ago that when the earth was energised with an interrupted current of low potential, the geological conditions of the earth's crust, through which the currents were flowing, altered the shape and changed the intensity of the field, which alterations could be detected by means of a telephone circuit connected to earth with portable electrodes.

This has taken a practical form for which Mr. Alfred Williams is responsible. He employs a portable battery, a transmitting apparatus, and a receiving circuit. And in use the transmitting electrodes are placed in the ground at 100 yd. apart. When the receiving electrodes are thrust into the ground within the field of influence, sounds can be heard from the attached telephones. These sounds vary with the character of the ground both in intensity and quality. The apparatus is worked by two operators, each with a receiving electrode, consisting of a steel rod 2 ft. long and a telephone; they alter the relative position of these electrodes in the field, and it is claimed that operators competent to detect and interpret the variations in the sound may find out the position, the size, and the character of a distant mass of mineral.

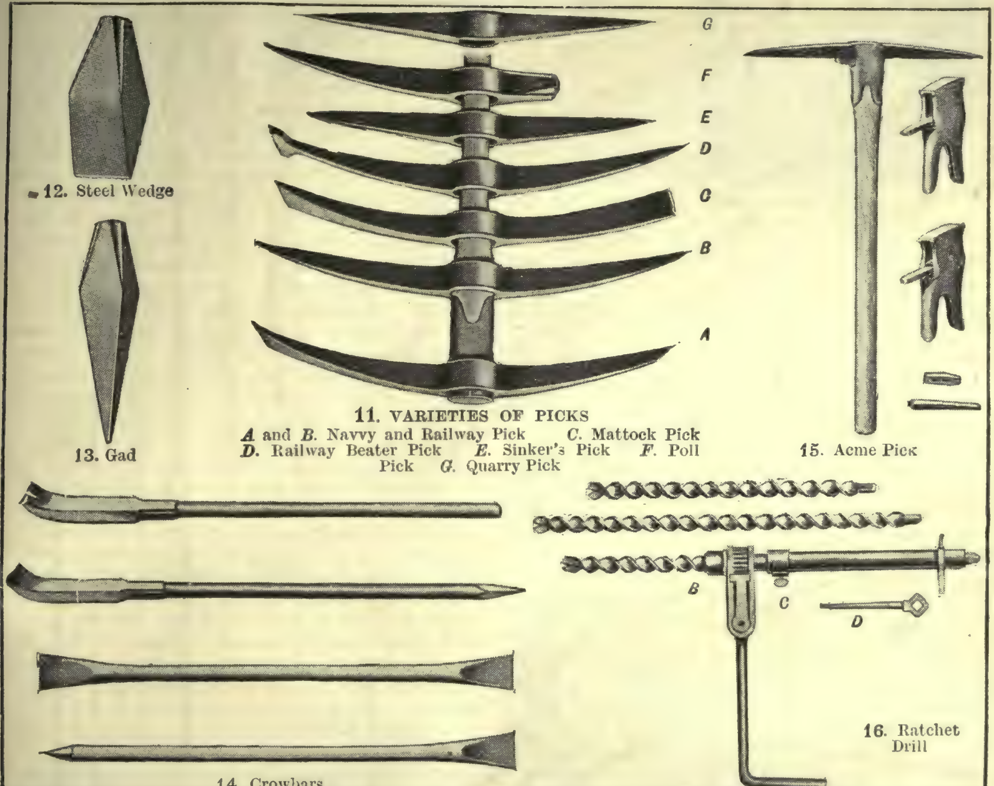
Boring. Portable hand boring appliances are used where deep-seated deposits are suspected, but at the stage to which reference is now being made—that is, the very first inspection of a country—it would be premature to embark on any deep-boring problem unless there were very good cause, such as geological evidence, or reliable records, for anticipating a valuable deposit lower down. But deposits to 50 ft. or so might be sought with a prospective boring kit, either percussive or rotary, to which reference will be made later.

It is exceedingly important to exercise great caution in the early stages of any mining enterprise; never entertain any costly outlay until sufficient good mineral is assured to yield a certain and ample profit on such outlay. Hence, if the search has furnished evidence of a promising deposit, that deposit must be proved to be good before incurring any heavy expenditure. It is advisable that the next operations should be conducted with due caution, and although devised so as to form part of a more extensive plan of work, they should at first be conducted on a moderate scale with simpler appliances with the sole object of rendering as much of the deposits accessible as possible. These operations make it possible to form a better judgment of deposit than can be gathered from the preliminary tests, and if it prove of less value than anticipated, and of a non-remunerative character, then no great loss will have been sustained, and the work may be abandoned without anguish. If, however, the deposit prove of value, these exploratory operations will be of immense value in deciding the character and magnitude of future operations, the amount of money that might reasonably be expended, and the kind of equipment that would be required to carry out the proposed work.

Proving Deposits. If the deposit be in the form of a well-exposed outcrop, it may be necessary only to clear away a certain amount of loose material, which can usually be done by picks, shovels, and wheelbarrows; and when a good face of stone, coal, or ore, as the case may be, has been exposed, some of it is broken down by means of a pick or by means of wedges or gads, or, better still, by blasting. A variety

of picks are shown [11], while 12 is a steel wedge and 13 a steel gad. These operations are repeated at various spots indicated by the observations made while prospecting, and if the deposit comes up to expectations, it would then be necessary to see that there was a good supply of useful deposit, while its position is of paramount importance. Accessibility to road, railway, river, or other waterway is desirable, so is the provision of a suitable site to give plenty of room for working purposes, for the disposal of waste, and for the accommodation of necessary buildings and machinery. The investigation of the supply and cost of labour, fuel, mining-timber, and water, should

Other picks have the ends forged to points or to chisel ends. The sharpening is done in the smithy. Various forms of picks are shown [11]. Sometimes it is convenient to have the blades readily detachable from the handles, so that for sharpening purposes the blades only need be carried backwards and forwards. The *Acme* and *Universal picks* of the Hardy Patent Pick Company are of this class. The Acme handle is provided with a socket at the top into which the blade passes. The blade has no eye, but is notched at the middle, and is held in position by a wedge, which can be easily knocked out when it is desired to remove the blade [15]. The handle of the Universal pick



12. Steel Wedge

13. Gad

11. VARIETIES OF PICKS
A and *B*. Navvy and Railway Pick *C*. Mattock Pick *D*. Railway Beater Pick *E*. Sinker's Pick *F*. Poll Pick *G*. Quarry Pick

15. Acme Pick

14. Crowbars

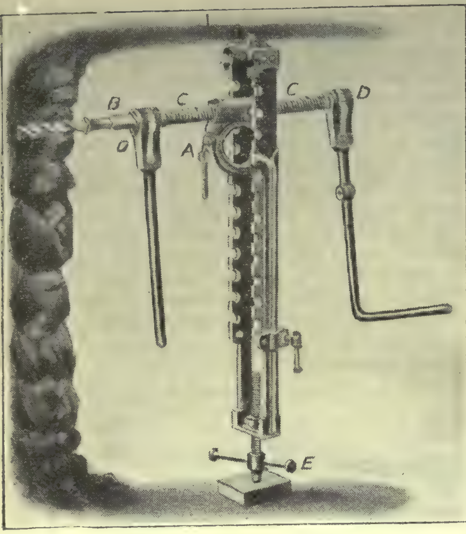
16. Ratchet Drill

VARIOUS MINERS' TOOLS (Hardy Patent Pick Co.)

also precede the systematic development of the prospect.

Implements for Proving Deposits. The *shovel* is used for excavating soft or loose ground, or for removing that broken up by other implements. The *crowbar* [14] is an iron lever which is used for prising off masses of stone or for shifting loose stones. The *pick* is a steel blade attached to a wooden handle, and used for breaking up ground. The blades [11] vary in form to suit the work, and are generally provided with an eye, into which the top of the handle is inserted and tightly wedged. The *pollpick* [11 F] has one pointed end and one flattened end, the latter for use as a hammer.

is larger at the top than at the lower end, and is provided with a spring socket [10, page 2380] at the upper end; the blade is furnished with an eye, and can be slipped up the handle, but it jams tightly on the larger end. When desired, however, it is easily removed by striking the small end on the ground. The picks shown [11], also the prospector's hammer, are of the Universal pattern. *Wedges* [12] with straight edges, or *gads* [13], which are pointed, are used to replace or supplement the pick in working out pieces of rock, and are used with a hammer or poll-pick. The implements just described suffice for many kinds of deposits, but when hard, dense rocks are encountered, or for fairly large bulks of



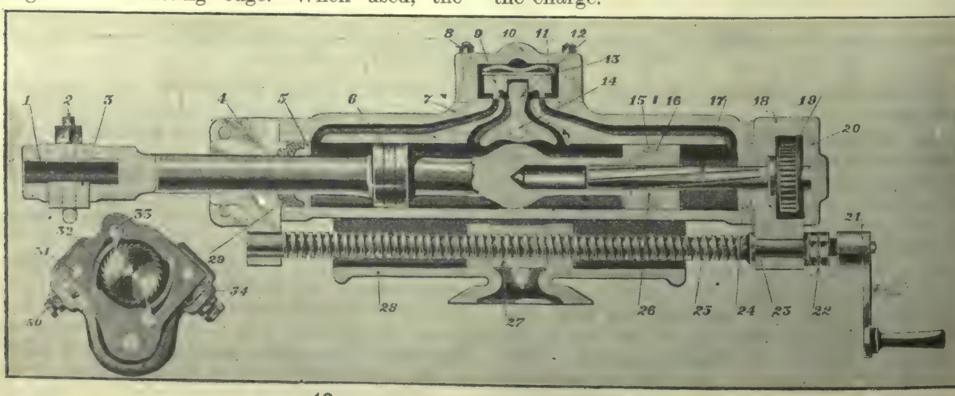
17. THE ELLIOT DRILL

softer rock, resort must be had to blasting, and for this purpose another set of tools comes into requisition.

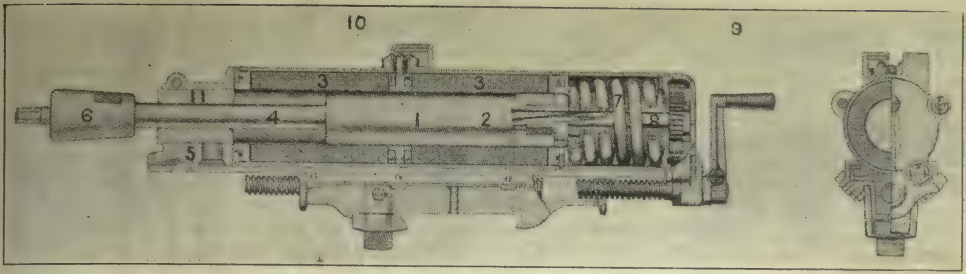
Blasting. Blasting is effected by making a hole in the rock, clearing it of dirt, putting a charge of explosive in the inner end, *stemming*, *packing*, or *tamping* the front part with clayey or other material, and igniting the charge by means of a fuse. The stemming prevents the escape of the products of the explosion; the force is therefore expended in rending the surrounding rock, which in consequence becomes shattered and fissured to a degree varying with the quantity and character of the explosive used. The shattered or fissured and fallen rock can then be removed by the use of the picks, shovels, etc. The holes are bored in soft rock by means of *drills* resembling *augers*; in hard rock by means of *jumpers*, or by *chisel drills* driven by *sledges* or *hammers*, or by rock drills.

Blasting Implements. *Jumpers* are iron bars with a swelling at the end or middle to give weight, and tipped with steel forged to a cutting edge. When used, the rock is usually notched with a blow or two of the pick, and then the jumper is struck repeatedly against the rock at that spot, being turned a little after each blow. In this way, a circular hole is made in the rock. Jumpers are made of different lengths, from a few feet up to ten or more, so that as the hole progresses longer jumpers are brought into use until the hole is sufficiently deep. In some situations jumpers, however, cannot be used; and also they would be very irksome and slow in very hard rock, so, under such crcumstances, and, as a matter of fact, in other cases too, drills come into use.

Drills are steel chisels. They chip the rock away like the jumper, but instead of giving the percussive blow by their own weight, they are held in the hand and given a blow with a sledge or hammer. When the miner guides the drill with one hand, and wields the hammer with the other, it is known as *single-handed drilling* [22]; when one guides and turns the drill while another gives the blow, it is known as *double-handed drilling*, which, naturally enough, is more rapid. A *scraper*, which consists of a disc of metal attached to a metal rod, is used to scrape the dust out of a bore hole. For muddy stuff, a *swabstick* is used. This consists of a wooden stick with the fibres at one end frayed into a kind of mop. A *charging spoon* is a half hollow cylinder of copper or zinc, with a wooden or copper handle, which is used for introducing loose gunpowder into horizontal, or nearly horizontal holes. The *tamping bar*, or *stemmer*, is a wooden, copper, or bronze rod with which the charge of explosive, frequently in the form of a cartridge, is thrust home. It serves, however, chiefly for ramming in the tamping to block up the front part of the hole, and is therefore grooved on one side to pass over the fuse in the hole without disturbing it. It must be made of material that, like copper, will not strike sparks when it comes into contact with the rock, as iron or steel would do. The *pricker* is another appliance which must fulfil this condition; it is a slender, tapering rod of copper or bronze, with a ring at the larger end. It is employed, when fuses are not used, for maintaining a passage in the tamping into which the *squib*, *rush*, *straw*, or what not can be inserted for firing the charge.



18. HOLMAN TAPPET VALVE DRILL



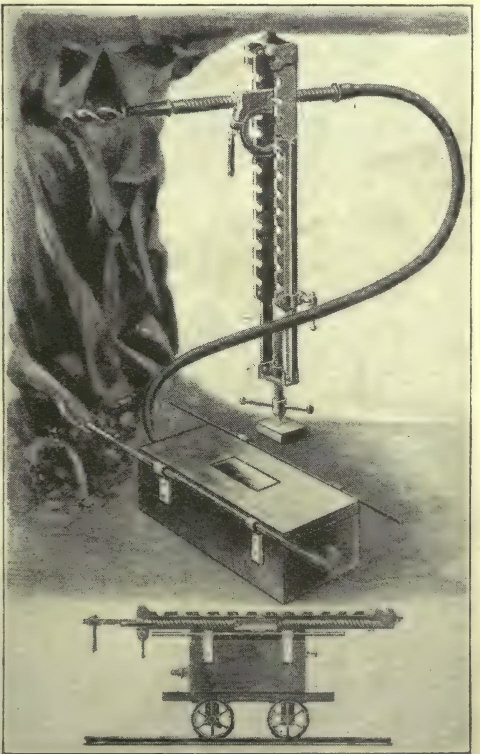
20. MARVIN-SANDYCROFT ELECTRIC DRILL

Mechanical and Power Drills. These drills are amongst the most important implements employed in quarrying or mining. With them holes can be drilled that could scarcely be contemplated by hand work, while even in ordinary drilling they are more rapid than hand work, especially in hard ground, where they can work five times as rapidly. Mechanical and power drills are either percussive or rotary, and there are a large number of good makers and good patterns; but it is possible only to mention a few types here.

Mechanical Drills. One of the simplest mechanical drills is the rachet drill [**16**]. It consists of an auger, A, inserted into a socket, B, attached to a feed screw which works in a nut, C, at the end of a long sheath, D. A ratchet, E, is fixed at the head of the auger, and by working the ratchet-handle the auger is turned, and at the same time the feed screw advances; the sheath is prevented from turning by allowing a pin, F, at the back end to jam against a piece of timber in the temporary support. When the feed screw has run out its full length it is run back, the use of a split nut at C facilitating this operation, and the auger can be replaced by a longer one. This drill is suitable for moderately hard work. The augers are made of twisted steel bar, which, to a certain extent, clears the hole itself.

The Elliot Drill. The Elliot drill [**17**] is another example of a mechanical drill of the auger type. The auger is inserted into a socket, D, on a feed screw, C, which, instead of working in a nut, works upon a worm-wheel held fast by an adjustable clamp, A. It is operated by moving a ratchet brace, D, backwards and forwards; this turns the feed screw and auger, and forces it into the rock; the clamp is adjusted to suit the hardness of the rock. When the feed screw has travelled to its full extent it is easily run back by loosening the clamp, and a longer auger is inserted before restarting. It will be observed that the drill can be placed at different heights on the stand, which can be tightened in position by the screw E.

Power Drills. For more expeditious work still, power is applied to working drills; compressed air, steam, water, petroleum, and electricity are all turned to account for this purpose, but the last three have not yet been extensively employed in mining. The simplest application of power to a drill is putting it to work on turning an Elliot drill, but the full advantage of power drilling is evinced in dealing with very hard rocks for which the auger drill would be unsuitable; in fact, machine drilling is done almost universally by percussive drills, which imitate the operations of hand drilling. They generally consist of a cylinder with a piston, which is given a reciprocating motion by compressed air; the cutting tool or chisel being firmly attached to the piston rod, deals a blow at each forward stroke. The turning of the drill at each stroke, to ensure a round hole, is usually effected by a rifled bar, and controlled by a ratchet wheel with pawls; the back end of the piston rod is hollowed out and provided with projections to fit the rifling of the bar, so it would turn during both the in and out stroke, but the pawls prevent the rotation in one



19. ELECTRICALLY DRIVEN ELLIOT DRILL
(Hardy Patent Pick Co.)

direction, hence the chisel gets the desired turn once each journey.

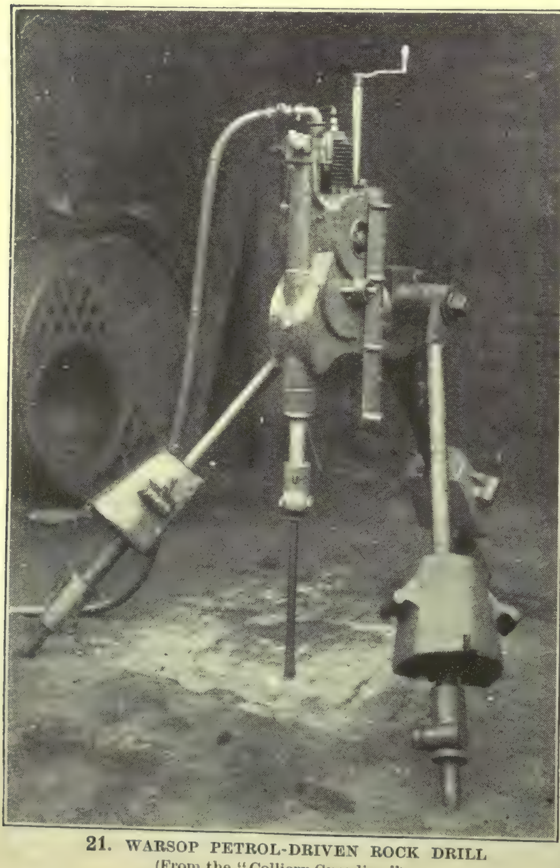
The machine is kept up to its work by means of a screw which works in a nut attached to the machine. A handle connected to the screw enables the man in charge to feed the drill forward upon the cradle which supports it; automatic feeding has also been employed, but is not much in favour. There are a very large number of types of these ingenious little machines, which vary mostly in the mode of working the valve. This is variously done—mechanically, by air pressure, by both these means combined, and by the use of an auxiliary valve to operate the main valve, while others have no valves at all—that is, the piston itself covers or uncovers admission or exhaust ports.

In the Civil Engineering course reference has been made to some rock drills, while the ordinary pneumatic caulking tool resembles in construction the drills of the third type. Hence, we need here notice only typical mining drills.

Drills with Mechanically Operated Valve. The Holman tappet valve drill is an example of this class [**18**]. It consists of a cylinder with two pistons connected together, but with a boss between them, which, when working backwards and forwards, sets a toppet rocking; and this works a valve of the ordinary D type so that the back and front part of the cylinder are alternately put into connection with the admission and exhaust ports. The exhaust is around the tappet into the cylinder between the pistons and thence to the atmosphere.

Drill with Valve Operated by Compressed Air. The Holman air valve drill serves as an example of this type of drill; in it the main valve is fixed to a spool, and is worked by the alternate exhaustion and charging of the space at the front or back of the valve chest, the alternation being effected by means of supplementary ball valves worked by the movements of the piston through the shoulders cut upon it for the purpose.

Drills with Valves Worked by Compressed Air and Mechanically. The Ingersoll-Serjeant auxiliary valve drill is an example of this class. The main valve is of the piston type, and, like other air-moved valves, is worked by the alternate exhaustion and charging of the back and front spaces of the valve chest; in this case this alternation is effected by means of a sliding valve made in the form of a segment of a circle and having a recess in one of its flat faces; it is slightly longer than its arc-shaped seat, so that one end of it always projects into the cylinder. The projecting end of this valve is caught by a shoulder of the piston as it passes, hence it is constantly being knocked backwards and forwards, and by reason of the recess putting one end of the valve chest in the other in connection with the exhaust.



21. WARSOP PETROL-DRIVEN ROCK DRILL
(From the "Colliery Guardian")

Electricity in Drilling. Various electrically-driven drills have been introduced, and **19** illustrates the application of electricity to the Elliot drill, the flexible shafting from a motor taking the place of the ratchet braces. At the lower part of the figure it is shown packed up for transport.

Fig **20** illustrates the Marvin-Sandycroft electric drill, made by the Sandycroft Foundry Company, Ltd.

The drill consists of a solid steel plunger, surrounded by two coils of wire, through which electric currents are passed. The plunger or piston (1) is a solid steel forging, having an enlarged portion (2) which is surrounded by the coils of wire (3-3), and a shank (4) which passes through a bearing in the front head (5) of the machine, and is provided with a massive chuck, or tool holder (6), for holding the drill steel or bit. The magnetic pull of the coils (3-3) draws the plunger (1) backward and forward as the current alternately passes through them. The rifled ratchet rod (8) is provided with a ratchet wheel in the back head (9), and enters a rifled nut in the back part of the plunger. The cushion-spring (7) is of a very heavy helicoidal pattern. The function of this spring is to assist in checking the backward stroke of the plunger. It thus

22. SINGLE-HANDED DRILLING
(By permission of H. W. Hughes)

absorbs the surplus energy of the return stroke, and supplies the energy thus momentarily stored to the forward stroke. The coils which form the body of the machine are encased in a steel tube, and the front and back heads are drawn together by side bolts. A flexible cable, consisting of three wires, terminating in a connection which fits into a socket on the drill, leads the current to the machine, and connection to the wires of the coils is made by means of brass plugs extending through the case as shown by 10.

The plunger runs freely, having a bearing in the coils and in the front head of the drill. The shank of the plunger travels through a bronze bushing (11).

The drill is mounted upon an adjustable tripod, column, or stretcher-bar, as may be required.

Petrol Drill. A drill driven by petrol is made by H. E. Warsop & Co., and is shown in **21**. The power is conveyed from a petrol motor, not shown, by the flexible shafting, and is converted to reciprocating motion by suitable gear within the drill casing.

Rock Drill Supports. Whenever admissible, a simple tripod serves the purpose of a support. It consists of a strong steel frame, with telescopic legs for the sake of adjustment, and well weighted to ensure stability. Fig. **21** shows a form of tripod. But generally, in underground workings the drill is mounted on a standard or stretcher bar, which, by means of lengthening screws, can be fixed tight either between the roof and floor or between the sides of a working. The drill is clamped so that it can be adjusted to any position.

Parts of Drills. The various parts of a rock drill are enumerated in the following list. The numbers correspond with those on the sectional illustration of the Holman tappet valve drill shown in **18**.

1. Bushing (holder)	18. End
2. "U" bolt	19. Ratchet
3. Pad	20. Ratchet cover
4. Cover	21. Handle
5. Buffer washer	22. Lock nuts
6. Piston	23. Buffer
7. Cylinder	24. Washer (ratchet end)
8. Valve box stud	25. Feed screw
9. Valve	26. Twist nut
10. Valve box	27. Feed screw nut
11. Valve spring	28. Cradle
12. Tappet	29. Packing
13. Rubbing plate	30. Liner screw
14. Tappet pin	31. Side bolt
15. Piston rings	32. Pawl spring
16. Piston springs	33. Pawl
17. Twist bar	34. Liner

Weight of Drills. The pneumatic hammer drill is as light as 16 lb., with cutter. The ordinary mining drill weighs 190 lb., a hand mining drill 240 lb., while heavy quarry drills may go up to 560 lb.; and there are many intermediate weights.

Blasting Materials. The substances used to cause the explosion consist of mixtures or compounds which contain combustible material intimately associated with material containing oxygen that will cause it to burn completely; the result is that, when such a combination is ignited, the whole mass is instantly consumed and mostly turned into a gaseous condition which would occupy many hundred times the space occupied by the solid were it not confined in the bore hole. It is the resistance offered to this expansion which creates an enormous pressure on the rocky sides of the bore hole, and results in their disruption. There are a great number of explosives used in mining, but for the preliminary work we are now considering those used would come under the following categories: *Powders* containing the combustibles sulphur and charcoal, with saltpetre as the oxygen supplier; explosives containing *gun-cotton* (this is a solid compound containing the combustibles carbon and hydrogen, along with nitrogen, and sufficient oxygen for their complete gasification); or explosives containing *nitro-glycerine*, which, like gun-cotton, is a compound containing nitrogen, carbon, hydrogen, and oxygen in such proportions that when disturbed by fire or shock they are instantly turned to gases with evolution of heat.

The powders are the least violent of these explosives, nitro-glycerine the most. *Blasting glycerine* is a mixture of gun-cotton and nitro-glycerine, and *carbonite* consists of nitro-glycerine, woodmeal, and saltpetre [see Explosives]. Where ventilation is bad, the products of the explosion must be taken into consideration in making the selection; while where inflammable gas is met with, as in the case of coal, either safety explosives should be used or the hole should be tamped with water to prevent the emission of flames that might ignite the inflammable gas.

Continued

FOR A SHORT DICTIONARY OF MINING TERMS see next page

A SHORT DICTIONARY OF TERMS USED IN MINING

See also DICTIONARIES OF GEOLOGY (page 2257), CIVIL ENGINEERING (page 1981), AND BUILDING (page 310)

ADIT—A gallery driven from the open-air into a mine; more particularly the gallery that drains a mine.
After-damp—The atmosphere produced by an explosion of gas in a mine. It consists of carbonic acid, nitrogen, and steam, with a small amount of the highly poisonous carbonic oxide.
Air-box—Wooden tubes for conveying fresh air to workings.
Air-courses—Passages for ventilation.
Air-crossings—Bridged passages for carrying one air-course across another.
Air-doors—Doors for regulating air-currents.
Air-pipes—Pipes for conveying fresh air to workings.
Alloy—A combination of two or more metals.
Alluvial Deposits—Deposits consisting of matter transported by water from higher ground.
Amalgam—An alloy containing mercury.
Amalgamation—The process of the formation of an amalgam; more particularly the use of mercury in the extraction of gold.
Amorphous—Without crystalline form.
Anemometers—Instruments for measuring velocity of air-currents.
Anhydrous—Free from water.
Arenaceous—Containing sand, or sandy.
Argentiferous—Containing silver.
Argillaceous—Containing clay, or clayey.
Assaying—Determining the amount of one or more specified constituents in mining produce.
Attle—Waste rock.
Auriferous—Containing gold.

BACKING DEALS — Planks placed vertically behind the curbs in a shaft to hold back loose fragments
Backs—The unworked portion of a vein above a level.
Bank—The surface land surrounding the mouth of a shaft.
Banket—Auriferous conglomerate consisting of quartz pebbles in a siliceous matrix.
Banksman—The man who receives the tubs at the top of the shaft.
Bar—See *crowntree*.
Basset Edge—Outcrop.
Battea—A very shallow slightly conical dish used for washing gold-dirt.
Bed—A stratified deposit [see *seam*].
Bed-rock—The rock upon which an alluvial deposit rests.
Bind—Shaley layers interstratified with coal-seams.
Bit—The chisel tip of a drill or the drill itself.
Black-band—An earthy carbonate of iron containing bituminous matter.
Black-damp—Carbonic acid gas, CO_2; *choke-damp*.
Blackjack—Zinc blende.
Black Tin—Dressed tin ore.
Blasting—Breaking away rock by means of an explosive.
Blende—Zinc sulphide.
Blower—A sudden emission of fire-damp in a mine.
Blue John—Fluor spar.
Bonanza—An exceptionally rich and persistent body of ore.
Bonnet—Covering to a cage to protect men from falling stones, etc.
Bord—A road driven in a seam at right angles to the main cleavage planes.
Bord and Pillar—See *pillar and stall*.
Bordways Course—The direction at right angles to the main cleavage planes. Also *on face*.
Bort—Opaque dark diamond.
Brattice—A temporary partition for purposes of ventilation.
Bucking—Crushing ore with the bucking iron.
Bucking Iron—A flat piece of iron with a wooden handle, used for crushing samples of ore.
Bunch—A small body of rich ore.
Bunchy Veins—Veins in which bunches occur.
Buntons—Timbers placed horizontally across a shaft.
Burrow—A heap; dump, or spoil heap.

CAGES—The conveyances consisting of platforms with framework used for transporting men, mineral, and material up and down a shaft.
Cap—A piece of wood placed on a prop in timbering. Also called *lid*. In metal mining, *bars* are called *caps*.
Caunter Vein—A mineralised cross-course.
Chimney—A continuous body of ore of moderate width but prolonged in depth.
Chocks—Stacks of pieces of timber laid horizontally with the alternate layers at right angles; also *cribs* or *cogs*.
Choke-damp—Carbonic acid gas, CO_2; black-damp.
Cleat—The more prominent cleavage in a coal-seam.
Cleavage—Planes of weakness in minerals and rocks along which they break up with comparative facility.
Cobbing—Removing adhering ore from pieces of veinrock with a hammer.
Cogs—*Chocks*.
Contact Vein—A vein lying between rocks of different character.
Corves—The small waggons or cars used for the conveyance of minerals, etc., in mines; also called *trams* or *tubs*.
Costeaning—Seeking deposits by sinking shallow pits and connecting them by an underground gallery.
Country—The rock or rocks in which a vein occurs; also called country rock.
Course—See *strike*.
Cradle—A wooden box with sieve mounted on rockers, used to wash gold-dirt.
Creep—The forcing up of the floor by the pressure of surrounding beds in mine roads and workings.
Crib—Framing timbers in a shaft; also a *curb* or a *chock*.
Cropping out—The appearance of a vein or bed at the surface.
Cross-course—A barren vein having a different direction to the main veins of a district; similar to a fault.
Cross-cut—A gallery driven in the country.
Crowntree—A piece of timber set on props to support the roof; sometimes called *bar* or *cap*.
Curbs—Frames employed as foundations for walling or tubbing in a shaft.

DEAD GROUND—Parts of veins without ore or deficient in ore.
Deadwork—Unproductive work.
Deads—Waste rock; *attle*.
Development—Operations conducted to render the useful minerals in deposits accessible.
Dial—A pattern of compass used underground.
Dialling—Surveying a mine by means of a dial.
Die—See *stamps*.
Dip—The deviation of the slope of a bed or vein from the horizontal.
Dipping Needle—A magnetised needle swinging in a vertical plain.
Downcast—The shaft through which the downward current of air passes into a mine.
Downthrow—The downward displacement of a seam by a fault.
Dressing—Separating ores from accompanying rock and minerals.
Drift—Any passage underground that is horizontal or nearly so.
Driving—Excavating drifts.
Dropper—A small branch vein on the footwall side.
Dumb-fault—A *wash-out*.
Dump—A waste heap; spoil heap.
Dyke—A vein of igneous rock.

EXPLOITATION—The productive work in a mine.

FACE—The exposed surface of mineral in a working.
Fault—The dislocation of a vein or seam. [See GEOLOGY.]
Feeder—A small branch vein.
Fiery—Containing explosive gas in dangerous proportions.
Fire-damp—Methane or marsh gas, CH_4.
Float Gold—Very finely divided or flaky gold, which floats on water.
Flookan or Flucan — A cross vein filled with clayey matter.
Floor—The stratum immediately below a seam or bed.
Flume—An artificial water-course.
Foot-wall—The under-wall of a vein.
Frame—An inclined wooden slab used in dressing tin ore.

GAD—A pointed wedge.
Gallery—A drift.
Gangue—The worthless portion of the contents of a vein; called also *veinstuff*, *veinrock*, or *matrix*.
Gate—A road kept open in the worked-out part of a mine; called also *gate-road*, or *gateway*.
Gin — A primitive form of winding engine; a whim.
Goaf—The worked-out ground of a coal-mine.
Gob—Same as *goaf*.
Gold-dirt—Earthy material containing particles of gold.
Gold-washing—Separating the particles of gold from the dirt by washing with water.
Gossan—The cellular and deeply stained material found at the top of some veins.
Grass—The surface of a metal mine.
Grizzley—A grating.

HADE—The deviation of the slope of a vein or seam from the vertical.
Hanger-on—The man who runs the loaded tubs on to the cage.
Hanging-wall—The upper wall of a vein.
Head Race—Aqueduct for the supply of fresh water.
Heads—The enriched products of ore-dressing. Also see *stamps*.
Headways Course — A direction parallel to the main cleavage planes.
Heave—The lateral displacement of a vein by a fault.
Hewer—The miner who *holes* the coal.
Hitch—A small fault.
Holing—Making the horizontal cut in a seam, usually below it, or in the lower part of it, called *undercutting*.
Horse—A mass of country in a vein.
Hushing—Flushing the surface away with water to expose a hidden deposit.
Hydraulicing—Washing away a deposit into special channels called sluices by powerful jets of water.

INBYE—Going from the shaft (underground).
Intake—The road along which the fresh air passes in a mine.

JENKIN—A road cut bordways course in a pillar of coal.
Joints—Natural divisions in masses of rock.
Jud—A working place driven in a pillar of coal.

Jigging—A process of ore-dressing and coal-washing in which sifting and water buoyancy act together.
Jumper—A weighted iron or steel bar with chisel end used for drilling holes in rocks by hand.

KIBBLE—A mining bucket.
Kindly—Applied to veinstuff and country; tender, soft, easy, promising-looking rock.
Kirving—Synonymous with *holing*.

LAGGING—Small timber driven behind the main timbering in shafts or drifts to prevent loose fragments falling through.
Launder—Water trough, also a *flume*.
Leader—A branch vein.
Leg—The upright timbers supporting the *cap* in vein-mining timbering.
Levels—Drifts driven along a vein.
Lid—See *cap*.
Lift—Any working place a few yards wide driven in a pillar of coal.
Lode—The profitable portion of a vein, frequently the vein itself.
Long Tom—A wooden sluice used in gold-washing.
Longwall—A method of working by which the mineral is removed in one continuous series of operations.

MAN-ENGINE—An appliance used for raising and lowering men in shafts.
Matrix—The material in which a useful mineral is embedded.
Metalliferous—Containing a metal or metals of the heavier type.
Middles—The intermediate products in ore-dressing operations.
Mineralised—Containing metalliferous minerals.
Mortar—See *stamp*.

NICKING—Making a vertical cut or groove in a face of coal.
Nip or Nip out—A sudden thinning of a seam or vein.

ON END—Headways course.
On Face—Bordways course.
Open-cast—Workings in the open air.
Ore—Mineral worked for the metal it contains.
Ore-dressing—See *dressing*.
Out-bye—Towards the shaft (underground).
Outcrop—The part of a deposit exposed at the surface.
Overburden—The surface material covering a deposit of useful mineral.
Overhand Stoping—A system of extracting ore from a vein by excavations made overhead.

PACK, OR PACK WALLS—Pillars of rough waste stone built to support the roof in mining.
Pan—A shallow dish used in washing gold.
Panels or Districts—Areas of a coal-seam isolated by means of barriers of untouched coal, to ensure more agreeable and safer conditions of working.
Panning—The operation of washing gold in a pan.
Parting—An inter-stratified layer of foreign material in a coal-seam.
Pass—A passage kept open for transmitting ore or rock to a level below.
Pay-dirt—The valuable portion of alluvial deposits.
Piling—Sinking shafts through loose ground by driving piles down, behind cribs or curbs.
Pillar—A block of mineral left to support the workings.
Pillar and Stall—A system of working in which the deposit is in the first working cut into blocks or pillars, which are subsequently removed in the second working; also known as *post and stall, bord and pillar, stoop and room*.
Pinch—A vein is said to pinch when it gets gradually thinner, and if it then disappears it is said to *pinch out*.
Pipe—Similar to a chimney, also the penetration of an upper bed into a lower one.
Pit—A shaft, also an open working in soft material.
Pitwork—The pumps and other appliances in the shaft.
Placer—An auriferous alluvial deposit.
Plat—An enlargement in a shaft.
Pocket—See *bunch*.
Pockety—See *bunchy*.
Post and Stall—See *pillar and stall*.
Pulp—In ore dressing, the product of the fine crushing of ore in the presence of water.
Punch-prop—A strut or distance-piece placed between the cribs in the temporary timbering of a shaft.
Putter—Trammer.
Pyritous—Containing pyrites.

QUARTZOSE—Consisting chiefly of quartz.

RAGGING—A heavier stage of spalling.
Raise, or Rise—A passage driven upwards in a mine.
Reef—A vein.
Riffles—Obstructions placed in the bottom of sluices, etc., to facilitate the deposition of gold, generally strips of wood.
Roof—The stratum immediately above a seam or bed.

SAFETY LAMP—A lamp in which dangerous contact between the external atmosphere and the flame is prevented by the use of wire gauze.
Sands—In ore dressing, the heavier products of hydraulic separators.
Seam—A tabular or sheet-like deposit forming one of a group of stratified rocks used in a more restricted sense than the term *bed*.
Set—A complete unit of framing in shaft or level timbering.
Shaft—A deep pit sunk from the surface.
Shaft Pillar—A block of mineral left to support a shaft.
Shoading or Shoding—Tracing detached stones to the parent vein.
Shoe—See *stamp*.
Shoot—A continuous body of ore extending downwards; also a *pass*, or the lower end of a pass.
Sill—The bottom member or sole-piece of a set of timber in a level or drift.
Skip—A rectangular box, working in guides in the shaft, used for winding ore or rock, etc.
Skirting—A road driven alongside fallen stone.
Slide—A small fault or dislocation.
Slimes—In ore dressing, the lighter products of hydraulic separators.
Sludger—A cylinder with a valve at the bottom for removing crushed stuff from a bore hole.
Sluices—The large wooden troughs used as a channel for the stream of water and dirt in hydraulic mining.
Sole-piece—See *sill*.
Sollar—A platform in a shaft.
Spalling—Breaking down lumps of rock or ore with heavy hammers.
Spitzkasten — Inverted pyramidal boxes used in ore-dressing.
Spitzlutten—Double V-shaped troughs used in ore-dressing.
Sprags—Short props of timber.
Stamp—A weight used in comminuting ore, consisting of a *head* in which is fixed a replaceable *shoe* below and a *stem* above; the stem carries a *tappet* which is periodically engaged and released by a revolving *cam*, causing the stamp to rise and fall. The stamp works on a *die* in a narrow box called a *mortar*.
Stamping—The process of reduction by means of stamps.
Stanniferous—Containing tin.
Staple—An underground shaft or *winze*; also a small pit.
Stemming—Tamping.
Stockwork—A deposit consisting of a number of small veins or patches of ore near together.
Stoop and Room—See *pillar and stall*.
Stope—The place where the mineral is won in a vein mine.
Stopping—A wall built to stop the passage of air.
Stowing—Filling a place with waste.
Stratum—A bed or seam.
Strike—The direction a vein or bed takes across country.
Stringers or Strings—Thin branch veins.
Stringing Deals—Planks employed to hang curbs together in the temporary lining of a shaft.
Studdles—Timber struts or distance pieces used to keep the *sets* apart in shafts in vein mining.
Stulls—Timbers or platforms fixed in stopes for supporting waste rock.
Stythe—Carbonic acid gas.
Sump—The lowest part of the shaft; a drainage pit.

TAILINGS—The impoverished and discarded products of ore-dressing operations.
Tail Race—Channel for conveying away dirty water and tailings.
Tamping—The material used and the operation of filling up a bore hole in front of the charge of explosive.
Tappet—See *stamp*.
Thill—The floor of a mine.
Throw—The vertical displacement of a seam by a fault.
Timbering—Fixing timbers to keep excavations free from obstruction by falls of stone.
Tinstone—Ordinary tin ore.
Trammer—A man who does the tramming of mineral and works the tubs.
Trend—Strike.
Tributers—Miners who work for a percentage of the profits.
Trommel—A revolving screen.
Tubbing—A continuous water-tight lining of a shaft.
Tut work—Contract piece work.

UNDERCUTTING—Holing beneath or at the bottom of a seam.
Underhand Stoping—Working out a vein downwards; the reverse to overhand stoping.
Underlie—Synonymous with *hade*.
Unstratified Rocks—Rocks not occurring in regular beds or strata.
Upcast—The shaft for conveying the vitiated air out of a mine.
Upthrow—The upward displacement of a seam by a fault.

VANNING—Separating ore from veinstuff by washing on a shovel.
Veinstone—The worthless material in a vein.
Veinstuff—Same as *veinstone, gangue*, or *matrix*.

WALLS—The sides of a vein.
Wash-out—A portion of a seam that has been denuded, also called a *dumb fault*.
Whim—See *gin*.
Whip—A winding pulley.
Whits—Partly dressed tin ore.
Winding Engine—An engine used for drawing mineral, etc., up a shaft.
Winze—A shaft extending from level to level.
Working in the Broken—Removing or *robbing* the pillars in the pillar and stall method.
Working in the Whole—Forming pillars by roads driven at right angles to each other, in the pillar and stall method of working.

continued from page 2477

HOW TO WASH CLOTHES

Preparations for Washing. Removal of Stains. Disinfecting Garments. Sorting the Articles. Flannels, Coloured Garments, etc.

By ALICE E. MARSHALL

IN order that the work of washing may be made as little troublesome as possible, it should be carried out systematically.

One day a week should be sufficient to set apart for washing, and this should be adhered to whenever possible. Monday or Tuesday may be chosen as most convenient, but it is undesirable that a later day should be selected.

Before washing day, the methodical housewife will look over her soiled linen, and attend to any mending that is required.

Removal of Stains. Stains, such as those of tea, coffee, and ink, should be removed before washing. Sometimes it is impossible to get rid of these by washing, and if the linen is allowed to go into the boiler with the marks still on, a permanent dye will result, as boiling fixes the colour. Stains may be removed from linen in various ways, different stains yielding to different treatment, as follows:

FRESH INK. Soak the stained part at once in milk or butter-milk.

IRONMOULD. Place the stained part over a basin, sprinkle with salts of lemon, and pour boiling water through it.

TEA OR COFFEE. Pour boiling water through the part stained at once; if this has no effect, sprinkle it with powdered borax.

WINE OR FRUIT. Sprinkle it with salt, and pour boiling water through it; add borax if necessary.

PAINT. This can be removed from white material with paraffin. For coloured materials, rub turpentine or paraffin on the spot.

GREASE. In the case of grease on coloured materials, rub the part affected with rectified benzine; as this is highly inflammable it should be very carefully used.

MILDEW is most difficult to remove. Wet the spots, rub them with soap, sprinkle them with chalk, and bleach in the sun. Repeat if necessary. Chloride of lime is effective in some cases, but needs to be used cautiously, as it may possibly destroy the fabric. After treatment the articles should be washed at once in the ordinary way.

Disinfecting. In cases of illness the clothes need disinfecting before being washed, and should be kept apart from the other linen. However slight the illness may be these precautions should not be neglected, as they may save a great deal of trouble and anxiety.

In serious illness of an infectious nature, the sanitary authorities take the responsibility, and do the disinfecting far better and more completely than is possible by a private person. The point aimed at in disinfecting is, of course, to destroy the germs which spread and carry disease, and which are frequently conveyed by clothing. The surest way of destroying them is by the application of great heat, but this is impossible in ordinary households without injury to the fabric, special appliances being necessary for the purpose. The usual method is to use some disinfectant, such as carbolic acid or Sanitas, which will destroy the power of the germs without injuring the colour or texture of the material. The disinfectant is added to the steeping water in which the clothes are placed directly after they have been removed from the patient. Two tablespoonfuls of carbolic acid may be added to one gallon of water, or the same amount of Sanitas may be used. It is well, in cases of influenza, to add the latter to the water in which the handkerchiefs are steeped, but it is not so powerful in its effects as the carbolic acid. Care must be taken in using the acid, owing to its being a deadly poison.

Chloride of lime and permanganate of potash are good disinfectants, but if used in sufficient strength to be of service, they may injure the colour and fabric of the articles disinfected.

Sorting the Clothes. When preparing for washing day, all soiled clothes must be collected and sorted into heaps, the flannels and prints being rolled up and placed on one side, as these need special treatment.

The usual method of sorting is to separate the articles in this way:

Table linen	Handkerchiefs
Bed and body linen	Muslin, laces, etc.
Starched articles: collars, cuffs, etc.	Coarse articles

These are put in different tubs, being well covered with cold water for at least twelve hours. This preparatory steeping greatly reduces the actual labour of washing, as it softens and loosens the dirt, making it much easier to remove from the clothes. If necessary, the starched articles may be put with the body linen, but the handkerchiefs must always be kept separate from other clothes. One tablespoonful of salt should be added to the steeping water, as this assists in the cleansing.

Preparations for Washing. On washing day, the worker should rise early, fill the copper, and light the boiler fire. The flannels and prints may be washed and put to dry out of the way. The latter are sometimes boiled, but this is not usual, as boiling affects the colours. Starch may be made ready, both hot and cold. The latter is generally used when great stiffness is required, as for collars and cuffs. Boiled starch is used for table linen, muslins, etc.

How to Make Starch. The best starch for laundry purposes is rice starch; the other kinds have much coarser granules, and are not suited for fine work. It will not properly dissolve in cold water, but only when boiling water is added; the cells burst, and a thick paste is formed. The best starch costs fourpence per pound.

BOILED STARCH

1 tablespoonful of white starch
2 tablespoonfuls of cold water
¼ in. of wax or tallow candle
½ teaspoonful of borax

Mix the starch to a smooth paste with the cold water; shred in the wax or tallow candle (composition candles must not be used); dissolve the borax in a small quantity of boiling water, and add it to the starch. Pour on sufficient boiling water to cook the starch, stirring all the time until quite clear and transparent; add cold water gradually, and use according to the desired stiffness.

Muslins and curtains require a stiffer starch than table linen; the finer and more open the fabric, the less starch it retains.

Borax is added to the starch to give a gloss to the linen, and tallow or wax to make the iron slip along easily without sticking.

COLD STARCH

1 tablespoonful of starch
4 drops of turpentine
½ teaspoonful of borax
½ pint of cold water

Mix the starch to a smooth paste with a little of the cold water and drop in the turpentine. If this is added at the last it swims on the top of the water and does not mix easily with the starch. Add the borax, previously dissolved in a little boiling water, then the remainder of the cold water.

Stir the whole well each time before use, as the starch sinks to the bottom of the basin. If the starch is good it will settle in a solid cake. In impure starch there is a sediment which will not dissolve; this sticks to the irons, and the work is ruined as far as appearance goes. After all the collars, etc., are done, the starch may be allowed to settle at the bottom of the basin; the water is then poured off, and the starch is used up for boiled starch. It should be kept covered until required. It is unsuitable to use again for cold starch, as the exact proportions cannot be ascertained, and as this is one of the most important items to note in the successful getting up of linen, it is not wise to attempt it.

Cold starch is always better if made a short time before it is required; the standing softens the starch grains and they burst and swell when the heat of the iron is applied, entering into the material and giving it the requisite stiffness.

The Washing of Flannels. Flannel articles should be sorted according to their nature and colour, the white ones being taken first, then the Jaeger and "natural," and the coloured last. The point to aim at in the washing of woollen and flannel garments is the retention of their soft nature without any shrinking or discoloration. The following points should be noted:

Do not leave woollen garments lying about wet; it causes them to shrink.

Avoid rubbing soap on them; the soda in the soap has a bad effect, causing them to harden, and also turning white wool yellow.

Avoid extremes of heat and cold; warm water is the best.

Do not dry the clothes in the sun or directly in front of the fire; they should not be allowed to "steam."

White Flannels. White flannels should be treated in this way:

1. Shake them to remove the dust.
2. Prepare warm water (one part boiling water to 1½ parts cold water is the right heat for washing and rinsing flannels).
3. Add sufficient melted soap to make a lather, and a few drops of ammonia to soften the water and remove grease.
4. Squeeze the articles gently in the water between the hands, but do not rub them; turn them and repeat the process until they are perfectly clean.
5. Rinse them in water of the same heat until all soap is removed.
6. Fold and pass them through a wringer two or three times.
7. Shake them well to raise the nap.
8. Dry them in the open air, if possible, hanging them up by the thickest part.

Woollen Articles. Jaeger and natural wool is washed in the same way as white, except that the garments may be steeped in the prepared water (that is, warm water, ammonia, and melted soap) about twenty minutes, the bowl being closely covered to prevent the escape of the ammonia. They will then be found to be practically clean, only requiring to be squeezed out and rinsed in clean water before wringing and drying.

Coloured Garments. Coloured garments may be washed like white ones, with the exception of the ammonia, which should be omitted, as it affects certain colours. The water should also be a little cooler, and the articles should be washed and dried quickly to prevent the colour from running. Salt is added to the rinsing water, as it assists in retaining the colour. One tablespoonful of vinegar may be used to brighten the colours, particularly red, blue or pink.

Stockings. Stockings are the only woollen articles to which soap is directly applied, and a little may be rubbed on the feet to get them perfectly clean; they must be turned and rubbed both sides until quite clean and soft. Stockings should not be washed in the water which has been used for white flannels, as the fluffy pieces come off the flannel and spoil the appearance of the stockings or socks. They should be folded down by the back seam in the natural shape, the foot being turned on to the leg part. Then pass them through the mangle two or three times to remove as much water as possible; hang them out in the open air to dry, pegging them up by the toes.

Continued

Group 28
TEXTILES
18
Continued from page 2445

'TWIXT SPINDLE AND LOOM

Reeling, Winding, and Spooling Cotton, Wool, Flax, Hemp, and Jute. Winding, Throwing, and Cleaning Silk

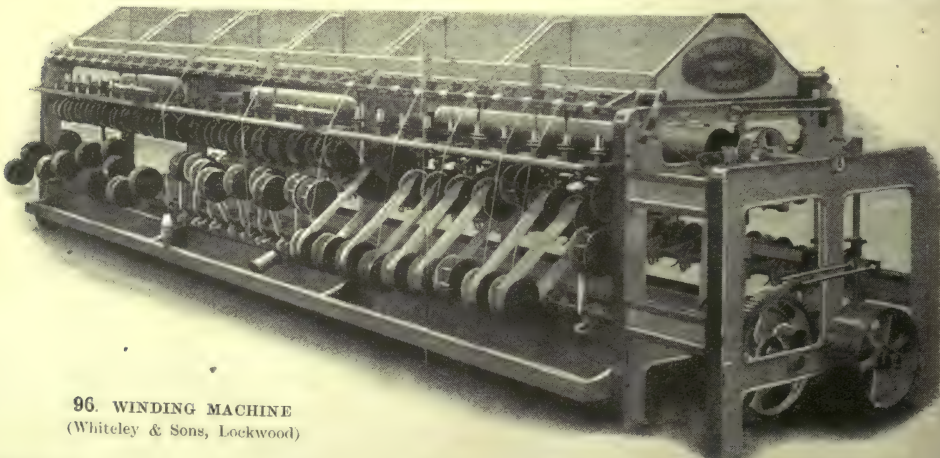
By W. S. MURPHY

Reeling. Spun yarn was always reeled into hanks in the days before mechanical invention had made the manufacturing process continuous. That is the reason why the measurements of yarns are based on the hank. When we speak of 40's yarn, we mean that so many hanks of a given length will weigh a pound. At present the young worker may be confused by the fact that none of the yarn he handles is made up into hanks at all. For example, many warp yarns are taken directly from the ring spinner on bobbins and put on the warping mill; still more commonly, the weft bobbins are wound on to the cops for the loom by the winders.

Most factories have a way of dodging the reeler, so that we have not nearly so many reelers as formerly. Reeling is not a difficult operation; the machine is the very simplest we use. The reel is a long cylindrical frame [98] hung on a spindle at the back of a machine on the front of which are set the cops or bobbins to be reeled. Through finger-like guides the yarn is led up and round the cylinder. The cylinder revolves till the standard quantity of whatever yarn we use has been wound on, and then it automatically stops. The indicator is generally of the worm-wheel type, every revolution of the reel giving it a turn, till it comes forward to the wheel or wire controlling the drive, and gives it the nudge.

Though not important in itself, the reeling operation is interesting as the basis of yarn measurements. We have complained about the lack of a proper standard of measurement, but the trouble really arose, in the first instance, from the different sizes of reels used. The standard was a revolution of the reel. A common worsted reel was 36 in.; the cotton reel measured 54 in.; the linen reel was 90 in. in circumference. With a unit so diverse, the multiples were bound to give different results. Linen manufacturers took 120 revolutions of the reel as the next unit; worsted men decided upon 80 revolutions; the cotton workers agreed to make 80 revolutions of the reel the standard also, but their reel was half a yard longer than the worsted one, and so the difference was perpetuated. With the comparative disappearance of the reel, we may hope that some universal standard will be possible at an early date.

Winding. Winding is the opposite of reeling, with a difference, and that difference still keeps winding an integral part of the textile industry. First, we require spools or *cops* for weaving. These may be formed from hanks or bobbins; but the winding must be done. Secondly, there is the silk winding, the yarn of which has been left on the bank, so far as we are concerned. Thirdly, there is the spool winding for all classes and kinds of threads. We arrive here at one of those points where the different branches of the textile industry have taken different departures at various moments. Some combine winding with doubling; others wind from hanks for weft; and others, again, wind the spools for the weaver from bobbins. These, and many other differences, may be viewed properly if we take the simplest first, and then develop as we go along.

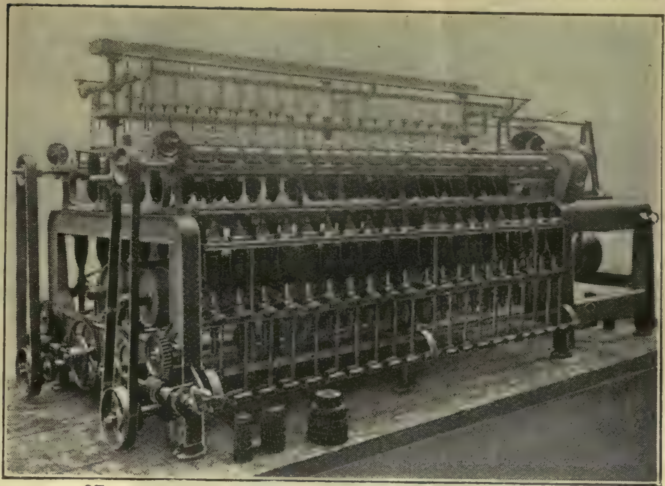


96. WINDING MACHINE
(Whiteley & Sons, Lockwood)

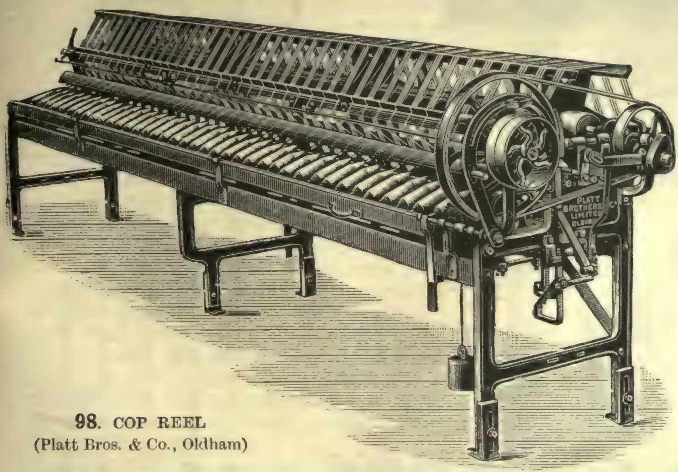
Cotton Winding. On the older form of winding-frame the hank to be wound is stretched on the reel at the back, and the cops or bobbins to be filled placed in front. But that order is reversed on the newer frames. At a slant, the

hank is stretched in front of the frame [96] on two sparred drums, and the yarn is drawn off and wound on bobbins at the head of the frame. The most noteworthy parts of those simple machines are the guides and stop-motion contrivances.

The form of the guide varies with the general character of the machine and the purpose to which it is devoted. In every case, however, it acts like a finger, holding the thread and carrying it to and fro along the bobbin, laying on each round with accurate regularity. In some machines the guide and the stop-motion apparatus are connected. For example, the end of the hooked wire connects the spindle with the drive; when held in position by the thread the wire maintains the drive; when the thread breaks or runs out, the wire falls and the spindle stops. In many ways this principle is worked in many machines, and the reasons for its use are very good. We must have the same length of thread on every bobbin, and the length is measured by the number of turns which the spindle makes. If the spindle were to run on after the thread had broken, our measure would be lost. As it is, all we have to do is to join the threads, hook up, and let the spindle begin again. The measure of the thread will be exact.

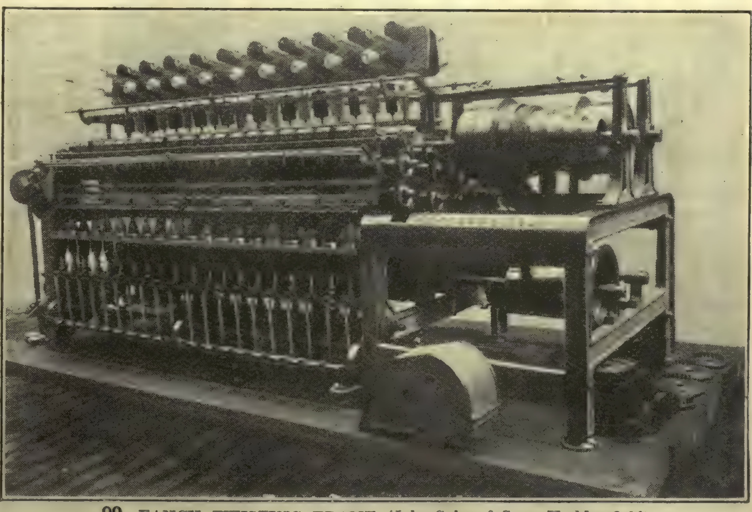


97. DOUBLING FRAME (John Sykes & Sons, Huddersfield)

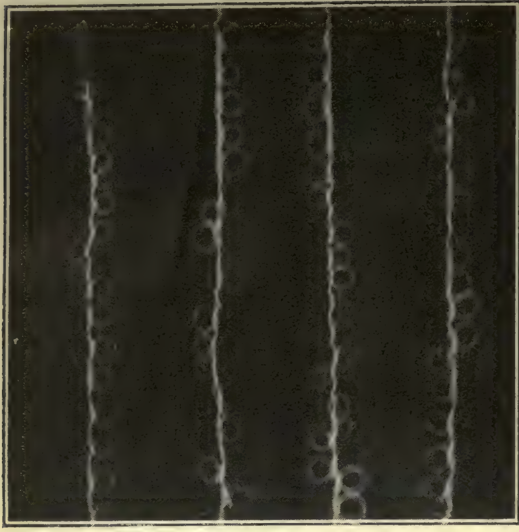


98. COP REEL (Platt Bros. & Co., Oldham)

The winding machines of the various yarns differ in size and in minor details, but no variation in principle is possible. One cop-winding method, however, should be noted, because it has affected the form of weaving shuttles in many branches of the trades. A hollow cone is geared over the bare spindle of the winding machine, and as the thread passes through the cone, by an oscillating motion, builds up the cop.



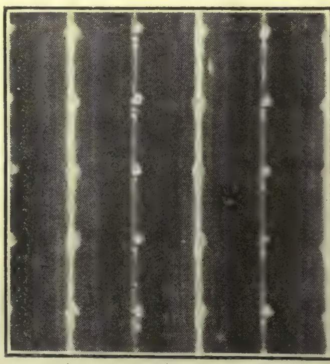
99. FANCY TWISTING FRAME (John Sykes & Sons, Huddersfield)



100. MOHAIR SPIRAL YARNS

By this means we have a solid cop which unwinds from the inside.

Doubling or Twisting. Strong threads are required for various purposes in the textile industries. We aim, in the first place, at obtaining a fine thread, and then we may have to double it to obtain strength. It is a curious fact that two fine threads are stronger than one thread of the same bulk. On the other hand, it is also true that a twisted thread does not fully represent the aggregate strengths of the yarns composing it. If it were possible to combine threads without twisting them, we should get better results; but it is obvious that this is not practicable, except in very rare instances. But this fact should be kept in mind—the firmly twisted thread seems to the inexperienced eye the stronger; in reality, some of the strength of the composing yarns has been used in forming the twist. We must twist to obtain unity, but any twisting beyond that is both unnecessary and injurious. In the ordinary factory doubling is accomplished on one of the three spinning frames—the throstle, the ring traveller, or the mule—with the sole difference that for the drawing rollers we substitute combining pulleys and carrier rollers. But the student has to be prepared for novelties in this department. Specially is this the case in sewing thread, silk, flax, and hemp. We purpose studying the sewing thread and silk processes separately, and leave them out of the account at present.



101. KNOPPED YARNS

Doubling Cotton. Light worsted dress fabrics, such as alpaca, lustre, delaine, cashmere, and coburg, are woven on a cotton warp as a rule. For these warps the cotton spinner doubles his yarn. If a fine, soft warp be desired, the doubling is best done on the mule, which gives sufficient twist to combine without hardening the thread. On the other hand, the ring traveller [97] is the best for producing cretonne or other hard-spun warps. This frame is also used by worsted manufacturers.

Fancy Yarns. There are two ways of producing fancy doubled yarns, of both cotton and wool. The one is by slack delivery, and the other is by what we call *knopping*. Take slack delivery first. If of two yarns running at the same speed one passes in straight lines to the twisting flyer, and one goes round through a series of rollers, the first must deliver a larger amount of yarn for the flyer than the second. At every twist a certain length of slack must be used up, and it is formed into a curl on the second thread. In this simple way the weft for imitation Astrakan is made in wool, and numerous fancy cotton yarns. Having achieved this end, further variation is obvious. By checking and giving out the slack, with simple automatic gearings, we can alter the disposition of the curls to almost any extent. Knopping, as the word suggests, has for its main principle a checking motion. Suppose, for instance, a tooth in the pinion of a drawing roller had become obstructed, and it jumped, the effect would be to produce a knob on the yarn; it would not be drawn, but curled into a soft knot. Application of the principle is easy; you may do it in various ways. For instance, when beginning work on the fancy twisting-frame [99], put a little draft on your rollers; let the one thread pass under one roller, and the other thread under two; set jumping pegs on the toothed wheels of the roller under which the slack thread runs; the result will be a pretty yarn. It is obvious that any number of variations can be wrought by combining the two methods. The illustrations [100, 101, and 102] show some of the most successful of these yarns.

Doubling-winding. Cotton, linen, jute, twine, and rope manufacturers use many kinds of doubling-winding machines. Some work on the up-twist principle, the bobbins on the feeding creels equipped with two, three, and four flyers, and twining cones in the middle of the frame. Others form the thread in tubes, and by giving the flyers an independent action, secure a long, even twist. Being such a simple operation, demanding only swiftness and regularity of twist, the machinists have experimented with every variety of thread-carrier, bobbin and twister, placing them in all conceivable relations. From one and all of these machines the doubler can only

demand a good sound thread, rapidly produced. As a rule, if intricate in mechanism, they may be safely disregarded, and if simple, they will be easily understood.

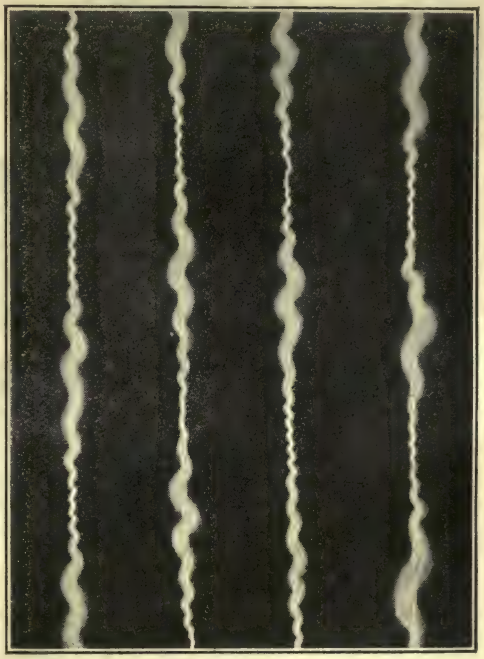
Conditioning Flax and Hemp. After it has been spun, the wet flax is dried in heated stoves, generally apartments over the boilers of the factory. Hung upon poles, within the heated room, through which a current of air is constantly driven by an arrangement of fans, the yarns are speedily dried. Next, the flax is made up in bundles, if for outside use or for sale on the market as yarns. Let us suppose, however, that we weave as well as spin. From the drying-room the yarns are taken and carefully boiled and washed. These are simple operations; but it is necessary to state that they must be done. When brought from the washing department, a considerable change is observable on the flax yarns. Not only are they cleaner, but they are also lighter and more flexible.

The boiling and washing process has seemed to many manufacturers unnecessarily severe on the linen yarn. Hemp yarns also need softening. These two facts in conjunction have led to the invention of dry softeners, designed primarily to soften hemp, but capable of being used for flax also. As a rule, the softeners are easily worked. The object being to give pliability to the yarns without alteration of their character, the softener must be used carefully. A very good type is the four-hank machine [103] made by Jennings, of Leeds. On each side are two pairs of flanged pulleys and a pair of drums, working on each other, with simple guides. The pressure of the softening drums is regulated by hanging weights, which are readily adjustable. The hanks are hung on the pulleys, and led through the guides in between the softening drums. The effect is undoubtedly to render the yarn more pliable and give it better spreading quality in the weaving.

Silk Spinning and Throwing. Spinning, in the strictest sense of the term, is not applied to silk; the silkworm has spun the thread for us, and we have to put it to use in producing textiles. Only when they have come off the spinning machines can the other fibres be said to be on a level with silk. This wonderful fibre in its raw state, however, has defects of its own, and the processes we name *spinning* and *throwing* are designed to remove these. Waste silk is spun like cotton or wool; but it must always be regarded as a subsidiary branch of the silk industry.

Sorting. In a former lesson we studied silk culture, and noted the various stages of the silkworm's life from the egg to the cocoon. We inquired into the structure of the cocoon and the various methods of reeling practised. When the raw silk arrives at the factory in this country it is made up in the hanks formed by the reelers of the cocoons. These hanks are first taken to the sorters, who open and lay them out for separation into the various qualities. Sorters have two methods of judging—one is by skilled sight and touch, and the other is by length to weight. We sort the silks into lots, according to the degree in which they possess these qualities: 1, fineness; 2, regularity; 3, clearness; 4, freedom from knibs or knots. Mechanical aids are useless here; sorting is a craft which can be acquired only by experience. Weighing, on the other hand, is purely mechanical.

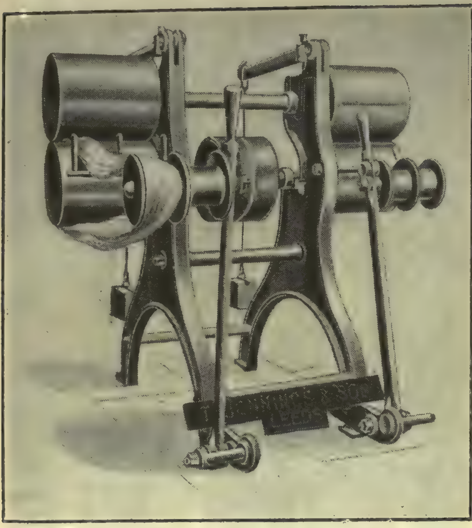
Winding. While we have many very fine modern winding machines adapted from the other textile industries, the simple and primitive silk-winder is still in use in many factories. The reel is composed of slips of lancewood joined in a hub on the supporting rod; on the head of the frame the bobbins sit on spindles between small pulleys actuated by the friction of a driving roller; in front are the guide wires fixed on a traverse rail moved to and fro by the cams at the sides. The hanks are hung on the reels, which, by their structure, are capable of taking on any size of hank, the stretch being made firm by



102. SPIRAL YARNS

bands of twine. Reels so large and light would very readily develop high speed and overrun; but a weight is attached to each, steadying the unwinding movement. A difficulty in all these winding machines is to obtain the smooth and regular delivery of the thread or yarn, friction being almost unavoidable. One of the best devices for getting rid of that trouble is the winding machine [104], which stretches the hanks on a pair of swifts slanted up towards the bobbins, and drives both bobbins and hanks by the same gearing. This equalises winding and delivery, and the lie of the hanks obviates all friction.

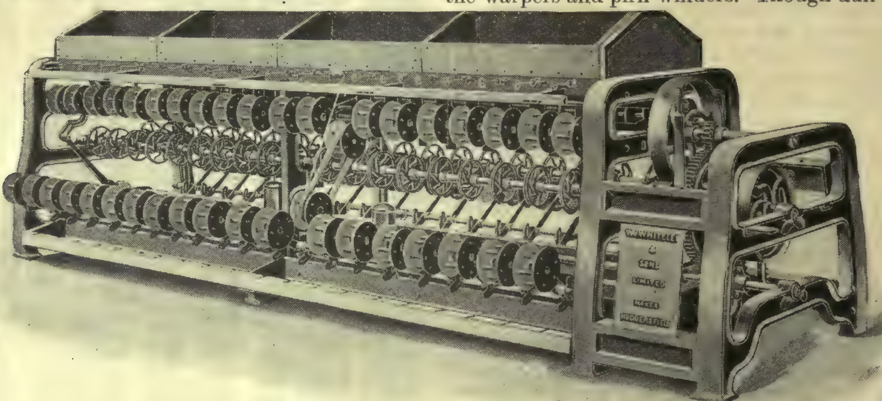
Cleaning. The cleaning, or re-drawing frame is also a simple structure, but the work calls for watchfulness and skill. Like every other, this department is always getting more



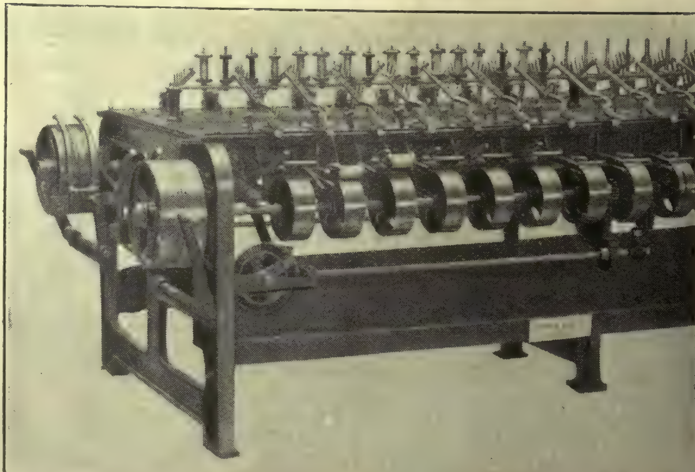
103. YARN SOFTENER (Thos. Jennings & Sons, Leeds)

and more improved machines. The latest is a cleaning-frame of high efficiency [**105**]. The bobbins are set on the head of the frame, and the thread is passed through sets of cleaners down to the bobbins, the winding of which is regulated by drums. More generally used, however, is the older type of frame. On the front of the frame is a bobbin board, which holds the bobbins on spindles; above it is the guide roller; behind, the cleaners or clearers sit in one long row; at the head, again, the receiving bobbins. Nothing in this machine is worthy of special note except the cleaners. Each cleaner is a pair of steel blades, set vertically in an adjusting screw, the edges of the blades facing, and in close proximity. The silk passes through the blades, which are adjusted exactly to the normal diameter of the thread, and cut away all knibs or irregularities. But another function of the cleaners here comes into view. The frame is so finely set that if the silk is too thick, it stops; if too thin, it tends to overrun. Therefore, the sizes of the spaces between the cleaner blades are delicately graded, the thick to the one hand, and the thin to the other. When a thread is stopped, it should be removed to the proper grade, and the same in the case of a thin one. So, by this arrangement, we obtain two classes of threads. Of course, the operation of cleaning may be repeated as often as may be considered necessary.

Doubling and Spinning. When the silk comes from the cleaners, three courses are open. We may use the silk as it stands for warp and weft of fine gauzes and light silk cloths. In that case the bobbins are sent straight to the warpers and pirn winders. Though dull and

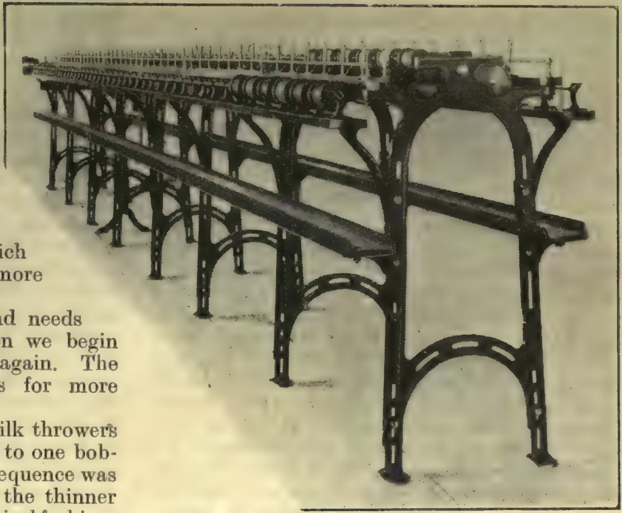


104. SILK WINDING FRAME (Whiteley & Sons, Lockwood)



105. SILK CLEANING AND GASSING FRAME (Greenwood & Batley, Ltd., Leeds)

lustreless on the web, these cloths are bleached into the most lustrous of all silks, because the natural gloss of the fibre is allowed to appear. Or we may want the silk for what is called *tram*, generally used as weft in heavy silk fabrics. In this case the threads are taken to a doubling-winding frame, and there put together with the lightest twist possible. Or, again, it may be *organzine* which is required, and in this case a more elaborate process is demanded.



106. WASTE SILK CLEANING FRAME
(Enoch Rushton & Sons, Macclesfield)

The first case explains itself, and needs no further study at present; when we begin weaving, these threads will appear again. The formation of tram, however, calls for more special study.

Tram. Up till a few years ago silk throwers simply ran two threads together on to one bobbin in doubling for tram. The consequence was that in the case of unequal threads the thinner wound itself round the thicker in a spiral fashion, when they were twisted. A more sensible method is to twist and double at the same moment, and this is done on the doubling-twisting frame. On a creel the two bobbins are placed together, and the threads led into a twiner; thence the doubled thread goes on to the flyer, which gives it the necessary twist, and lets the bobbin wind the silk round itself. It is considered that about five turns to the inch is quite enough for tram.

107. ORGANZINE-SPINNING FRAME
(Enoch Rushton & Sons, Macclesfield)

Organzine. The making of organzine involves several operations. First, the single thread has to be twined into what is called "singles." The approved method of performing this work is by the use of a kind of inverted throstle-frame. The bobbin containing the cleaned thread sits on a creel at the bottom of the frame, and on its head is a curious flyer, one leg by the side of the bobbin, and the other twined round a wooden boss on the head of the spindle and turned upright. Above is the traverse rail, with an eyelet, and on the head rests the receiving bobbin. The bobbin holding the cleaned silk is stuck firmly on the spindle, and, of course, the flyer is driven at the same speed. Through the eyes on both legs of the flyer, and up through the eyelet of the traverse rail, the silk passes on to the bobbin, the amount of twist being determined by the difference between the rates of speed of the delivering and the receiving bobbins. If the silk were taken on as quickly as the delivering bobbin turned, there could be no twist.

Having got our *singles*, as the twisted thread is called, we now proceed to doubling and twisting. This may be performed either in one operation, as described in the formation of tram, or we may double first, and then twist. Serious objection to two operations is not taken, because the singles, being twisted, have some body. One thing must be observed—the doubling twist should be contrary to the twist of the singles, so that

the pull of the singles to untwist confirms and hardens the twist of the doubled threads. Silk net-thread is best treated on the double-tiered machine [107], which "spins" a large amount in a short time.

As we have more than hinted, the student of silk-throwing will learn his own trade and a little more by paying close attention to the winding and doubling operations of the other textiles. In machinery this is especially the case.

Reeling. When the silk leaves the doubling frames, either as tram or organzine, it is reeled again into hanks. This time the winding operation is reversed, the reels taking on instead of giving off the hanks. Many forms of reeling machines are made, but the operation, being merely the unwinding of a bobbin on to a reel, is simple. Self-acting count-guiders and stop motions have been attached to all reeling machines, each maker having a special contrivance, or, rather, special adaptation, of the principle common to the whole trade. By the automatic count-guide it is possible to make the hanks of any length desired. Skeins, or hanks, had no common measure till very recently. The unit most generally accepted is 1,000 yd., skeins of 500 yd. and 250 yd. being denominated half-skeins and quarter-skeins. Some firms stick to the old French measure of 520 yd. Similarly, the standards of weight differ. The English unit of 1,000 yd. is weighed in avoirdupois drams, the silk being named according to the number of drams the skein weighs. With skeins of the French length, the weight is expressed in an old measure called *denier*, of which we find 20 equal 16½ gr.

Though the varieties of silk yarns are very numerous, the methods and machines we have examined represent all the principles involved. The silk-thrower's work is mainly doubling and twisting, and these operations, while calling for considerable care and practical skill, are easily understood and quickly learned.

Spun, or Waste Silk. After the waste silk has been spun into thread, it comes into line with the reeled silk. When spinning it we saw a lot of irregularities, knibs, and knots, and these may be removed by the same cleaning process as has been given to common silk, or by another process called *improving*. We have two different kinds of improvers. One is a frame [106] with little glass eyelets, through which the thread is drawn from one bobbin to another, the glass clearing away the irregularities in the same way as the cleaning blades. The other is rather more ingenious in principle, though not so economical in practice, and therefore not so much used. It is worth studying, however. On a cleaning bar revolving spindles are ranged in the frame, and in its passage from bobbin to bobbin the thread winds itself round these and rubs, the friction effectually wasting away the lumps and knots. Improving lessens the bulk of the thread more than might be desired, but the improvement is certainly very remarkable.

Gassing. The improving operation takes away the knibs, or knots, but it leaves untouched, and even exaggerates, another defect which would lessen the value of the yarn very considerably if it could not be got rid of. When taken off the improving machine, the silk appears dull and lustreless. Examining it attentively, we see that the thread is covered with a soft down, which, under the microscope, seems a hairy coating. Those slender filaments intervene between the straight fibres of the body of the thread and the light, and so hide their lustre. Fortunately, some time before waste silk spinning had become a very important branch of the textile industry, the gassing frame had been invented.

In 1817, Samuel Hall, of Nottingham, invented a gassing apparatus, primarily designed to remove the floss from the threads of lace, but applicable to all classes and kinds of threads and fabrics. The gassing machine commonly used by the spinner of waste silk closely resembles the improver, with the difference that, instead of the glass eyelets or upright steel blades a row of gas-jets are placed in the way of the passing threads. These jets have not the white flame of ordinary gas, because they are cooled by air, to moderate the heat for the fine threads of yarn. From bobbin to bobbin, the threads are led through the little blue jets, and are cleared of the floss, which is burned off in the flames, while the body of the yarn remains uninjured.

Various patterns of gassing frames are to be had, and we do not feel disposed to question the efficiency of any. The user of the gassing frames, however, must observe certain points. Some silk yarns are more tender than others, and need to be gassed more rapidly, or in a lower degree of heat, than others. Again, the yarn should not be drawn, or otherwise wrought, on the gassing machine, and therefore delivery and taking-on should be perfectly equal. If desired, the gassing operation may be made part of the winding or spooling. On these frames, the gas-jets are set amid the reach between delivery and winding-on spools, and so consume the floss from the thread as it passes.

Thus cleared of floss, the waste-silk yarn shows a lustre rivalling that of its more costly rival.

Because the yarns of spun silk are more uniform and rounder than those of thrown silk, they are preferred for machine sewing-thread and laces. From being regarded as an inferior intruder, the waste-silk industry has attained an integral position among textiles.

Continued

PROPERTIES OF LIGHT

Reflection of Light and its Laws. A Study of Reflected Images. The Real Eyes are in the Back of the Head. The Kaleidoscope

Continued from pag 2436

By Dr. C. W. SALEEBY

The Facts of Reflection. Having defined the terms *transparent, translucent,* and *opaque,* and having noted the fact that light may be absorbed by a material body, we must now inquire into the laws which determine reflection of light from those bodies which, exactly in so far as they do reflect it, are opaque.

"When a ray of light," says Professor Tait, "moving in one homogeneous medium falls upon the bounding surface of another homogeneous medium it is, in general, divided into several parts, which pursue different courses. These parts are respectively (a) *reflected,* (b) *refracted* (singly or doubly), (c) *scattered,* (d) *absorbed.*"

In certain cases the whole of the light is reflected, and this we call *total reflection.* In general, the reflected portion of a ray of light is much greater when the new medium is, for instance, mercury than when it is, for instance, water or glass. But, apart from these differences, the rule is that the amount of light which is reflected in the case of any given medium is, in general, greater as the angle of incidence is greater. This, in ordinary language, means that the more obliquely the light approaches the surface, the greater is the amount of it which is reflected. In the case of surfaces which do not scatter the light, the portion of the ray which is refracted—that is to say, passed through after bending—consists of all that is not reflected. Hence it follows that the refracted portion of the ray in such cases diminishes as the angle of incidence increases.

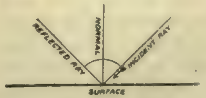
Scattered Light. Now before we go on to consider the laws of reflection from smooth surfaces, we must dismiss that irregular reflection from irregular surfaces which is called the scattering of light. In such cases "the common surface of the two media becomes illuminated and behaves as if it were itself a source of light, sending rays in all directions" (Tait). Ground glass affords a familiar instance of a substance which scatters in all directions the light that falls upon it. Thus, when a piece of ground glass is interposed between the eye and a source of light, the light is scattered at the surface of the glass, which becomes visible at every point, while the form of the source of light can no longer be detected. We have already seen that such glass would be technically described as translucent, and we now see that translucence depends upon the scattering of light. When light falls upon an opaque body, the surface of which is not polished, it is reflected and scattered. Hence all points of the reflecting body are visible to the eye, notwithstanding what we shall afterwards come to recognise as the *laws of reflection.* The action of these laws presents a similar result when the surface of the body is polished. In such cases the surface may become quite invisible, as, for instance, when one walks into a mirror by mistake; or it may be visible only if the eye be placed at a certain point. The best description of the scattering of light and its relation to reflection is given by the late Professor Tait, one of the greatest physicists of the nineteenth century, and the coadjutor with Lord Kelvin in the production of the greatest of all works upon physics. We will, therefore, quote his authoritative words. He calls the paragraph which we quote the "*Visibility of non-luminous objects.*"

Visibility of Non-luminous Objects. "It is by scattered light that non-luminous objects are, in general, made visible. Contrast, for instance, the effects when a ray of sunlight in a dark room falls upon a piece of polished silver and when it falls on a piece of chalk. Unless there be dust or scratches on the silver you cannot see it, because no light is given from it to surrounding bodies, except in one definite direction, into which (practically) the whole ray of sunlight is diverted. But the chalk sends light to *all* surrounding bodies from which any part of its illuminated side can be seen, and there is no special direction in which it sends a much more powerful ray than in others. It is probable that, if we could with sufficient closeness examine the surface of the chalk, we should find its behaviour to be of the nature of reflection, but reflection due to little mirrors inclined in all conceivable aspects, and at all conceivable angles, to the incident light. Thus, scattering may be looked upon as ultimately due to reflection. When the sea is perfectly calm we see in it one intolerably bright image of the sun only; but when it is continuously covered with slight ripples, the definite image is broken up, and we have a large surface of the water shining by what is virtually scattered light, though it is really made up of parts each of which is as truly reflected as it was when the surface was flat."

The Laws of Reflection. The first law of reflection is as follows: When light is reflected from a surface, the incident rays of light, the normal to the surface, and the reflected ray of light, are all in the same plane.

By the normal to the surface is meant a straight line drawn from the surface at the point where the light strikes it, so as to be perpendicular to the surface.

The second law of reflection states that the angle between the incident ray and the normal is the same as the angle between the reflected ray and the normal; or, in more familiar language, the angle of incidence is equal to the angle of reflection [see illustration]. These two laws



may be stated in another form. The angle of incidence and the angle of reflection are equal to one another, and in one plane. Or, in yet other terms, if light be reflected from a plane surface, the incident and reflected rays are in one plane with, and are equally inclined to, the perpendicular to the reflecting surface at the point of incidence.

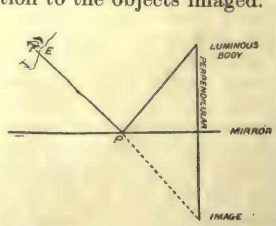
Explanation of the Laws. These laws are abundantly capable of experimental demonstration. Says Professor Tait: "The best experimental proof of the truth of this statement is deduced from the use of a reflecting surface of mercury in observations with the mural circle. The graduation of such an instrument is the most perfect that human skill can accomplish, and no one has ever been able to find by it the slightest exception to the preceding statement."

A phrase in the above quotation must be explained. In order to ascertain the height of a star above the horizon, or its altitude, astronomers often use a telescope which can work on a vertical circle, the graduation of which is as delicate as Professor Tait asserts. Such observations can demonstrate the truth of the law, since part of the operation consists in the observation not only of the star directly, but also of the image of the star in a bath of mercury, having a horizontal surface, to which the telescope is pointed after it has been pointed directly at the star itself.

Now what is the theory of light which will serve to explain these laws? In point of fact, they could readily be explained on Newton's corpuscular theory of light. We have merely to assume perfect elasticity on the part of the corpuscles, and the laws of reflection would be obeyed. The corpuscles would bound from the reflecting surfaces exactly like billiard balls from a cushion. But though the explanation is not quite so obvious, these laws of reflection are absolutely compatible with the wave motion or undulatory theory of light. It would take up too much space and require a certain amount of geometrical knowledge, which must not be assumed, in order to go into the details of this explanation; but the reader can draw for himself an interesting diagram showing what must happen when a wave, no matter whether of light or of sound, obliquely strikes a surface and is reflected from it. The wave, of course, must be drawn as having a wave front—a plane wave front—which can be represented by a straight line, moving forward in a direction at right angles to itself.

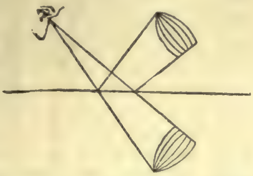
The Law of Least Time. From the laws of the reflection of light, it follows, according to what is known as *Fermat's law*, that the path taken by a ray of light, once reflected on its course between two points, is that which can be travelled over in the least possible time. This can be stated more comprehensively thus: If a ray pass from one point to another, after any number of reflections at fixed surfaces, the length of its whole path from one point to the other is the least possible—subject to the condition that it shall *meet* each of the reflecting surfaces. "For the point in a given plane, the sum of whose distances from two given points (on the same side of the plane) is the least possible, is that to which, if lines be drawn from the points, they are in one plane with the normal or perpendicular to the given plane, and make equal angles with it." The reader should draw a diagram to illustrate this. In association with this law we must always have in our minds a further law, which can here be merely asserted, though it is implied in Fermat's law—that when a ray of light, or, indeed, any form of wave motion, is refracted or bent when passing from one medium into another in which it has a different velocity, its path from any point in one medium to any point in the other is always shorter than any other possible path. It is the shortest possible path. It might be thought, of course, that the straight line between the two points would be the shortest path. It is, of course, the shortest in length, but not the shortest in time. It is inferior in this respect to the bent path which the ray actually takes when, for instance, it passes from air to water. Less time is occupied in traversing this path, since a higher proportion of the total time is devoted to the passage of the light through that medium which permits of the most rapid propagation. In the instance we have quoted, this medium is, of course, the air. Similarly, it saves time to go a little out of one's way *on a motor 'bus.*

Formation of Images. When the eye perceives an image in anything—as, for instance, that of a candle—as the result of the reflection of light from a plane surface, it is always deceived, precisely as the ear is deceived by means of an echo. The information given us by the eye depends merely upon what immediately reaches it. It can tell us nothing whatever of the previous history of the light, any more than the ear can tell us the history of a sound wave prior to its reflection from an echoing surface. When we look at the image of a candle in a flat mirror we can state a simple law which enables us to locate exactly the position of that image and its relation to the objects imaged. "The image of any point in a plane mirror is found by drawing from the point a perpendicular to the mirror and producing it till its length is doubled" [see illustration]. The drawing will make the statement of the law appear as simple as it really is. In such a case the eye, of course, is completely deceived. It seems to see the object in the depths of the mirror, and the image thus formed is called a *virtual image*. Another way of finding it is, of course, to produce the line E—P until it reaches the point already ascertained, by drawing and doubling the perpendicular from the luminous body to the mirror. Rays proceeding from the luminous body behave, after reflection, just as if they came from the image found in the way we have described.



Real and Virtual Images. Such an image as this is called a *virtual image* because only the reflected rays appear to come from it. It is only their directions produced backwards in imagination that lead us to it. There are real images, however, which are so-called because the rays of light have actually passed through them.

The case is only very slightly complicated if for the luminous point we substitute a body of some size, which, of course, consists of an infinite number of luminous points, each of these behaving according to the laws already stated. Light coming from any point of this object and reflected in the mirror will appear to come—to vary the words we have previously used—from a point so placed that the line between it and the actual point is bisected at right angles by the mirror. Such a virtual image is reversed, as is, of course, known to everyone who has ever looked at himself in the glass, and as may be shown very strikingly by attempting to read the reflection from a printed page in a mirror, and then by holding up to a mirror a piece of blotting-paper which has just been used.



The accompanying diagram will readily show why the image must be reversed.

Mirror-writing. Since it is well to co-ordinate our knowledge, we may here comment upon that extraordinary form of writing which in certain nervous disorders is executed from right to left, so that when it is reflected in a mirror it looks like ordinary writing, and when looked at directly it is identical with the marks which ordinary writing would make on blotting-paper. It is always written with the left hand, and in many cases the patient is totally unaware of any peculiarity in the writing. One patient "wrote letters to her friends in mirror fashion and was surprised she did not receive answers from them." A certain number of perfectly healthy persons, when asked to write with the left hand, write mirror-wise, and it is recorded that one of Leonardo da Vinci's manuscripts is thus written, while we know that in his later years his right hand was paralysed. We shall not here attempt to explain mirror-writing. It is an extremely puzzling phenomenon, and can by no means be readily explained. Some of the facts we have quoted seem to show that the patients see the writing in different fashion to ourselves, and this introduces us to a subject which, though not usually considered in this place, if dealt with at all in the textbooks, is yet properly given attention here.

Retinal Images. Having spoken of real and virtual images, having noted how, in certain conditions, images are inverted, and having described the extraordinary peculiarity of vision which is exhibited by many mirror-writing patients, let us ask ourselves the most interesting of all the questions which are concerned with sight. In due course we shall discuss the eye as an optical instrument—incomparably the most wonderful of all optical instruments, notwithstanding the remark made by Helmholtz, though quite unworthy of him, that "if it were sent him by a scientific instrument maker, he would promptly return it as grossly defective." Owing to an extremely simple fact, all the images which are formed upon the retina are inverted. The eye contains a doubly convex lens, and the consequence of the passage of the rays of light from any object through it is to cause an inverted image to fall upon the retina. This fact is quite beyond dispute. Thus, in the case we have described, where, by reflection, an inverted and virtual image reaches the eye, that inverted image is reinverted so as to form a non-inverted, or upright, image on the retina. But while we interpret an inverted image as not inverted—that is to say, while we do not see things upside down, even though the images of them in our eyes are upside down—yet in this case the re-inverted image is interpreted by us as if it were once inverted. We see a tree reflected in water as if it were upside down, and the tree itself as if it were right side up, yet in point of fact the image of the tree itself is upside down upon the retina and the image of its reflection in the water is right side up upon the retina.

We See Everything Upside Down. When this fact of the constant inversion of every retinal image is first presented to the consideration of the student, he usually finds it absolutely incomprehensible—and no wonder. As long as we confine ourselves to physical conceptions, it is incomprehensible. What else can be said of the two facts, each true in its own sense, that we see everything upside down, and that, notwithstanding, we see everything right side up ? In order to understand this paradox it is necessary to seek the help of psychology, The young student begins physics before he is aware, perhaps, of the existence of psychology. and certainly long before he suspects that there may be anything intelligible and interesting in it. Why do we not make the most ludicrous mistakes, he asks, if we really see everything upside down ? And this question leads to an explanation which seems, at first sight, plausible. Perhaps, though we really see everything upside down and with its right side on the left—perhaps, though every retinal image is inverted, we are saved by experience. The sense of touch is not similarly deceived, and by gradual years of education we learn to allow for the deception which our eyes would seek to practise on us. When the young thinker has reached this point there will occur to him, it is to be hoped, a possible means of testing his supposition. Let us suppose the case of a person born blind, owing perhaps to some opacity of the lens of the eye. Suppose, now, that by the time he has reached adult life, surgery has so far advanced that the opaque lens can be removed and an artificial lens of glass substituted—not inside the eye, of course, but in front of it. Will such a patient be astonished to see everything upside down, and will he only gradually learn by experience to correct his impressions ? Will his case, indeed,

be something like that of the boy who learns to shave himself before a mirror and who gradually learns to allow for the difficulties ?

Our Eyes are at the Back of our Heads. The answer is that in such cases the patient does not see things upside down. He is not deceived even at the first. That explanation is not tenable. The true explanation is that our whole conception of what constitutes the act of vision needs *revision.* We have not yet thought about it in any real sense. We are thinking of mind in terms of space. But space or extension is not a property of the mind. We have unconsciously formed a sort of notion of the mind, or thinking subject, as standing upright somewhere behind the eye and looking at the inverted images which are thrown upon the retina at the back of the eye. This, however, is quite false and ludicrous. In point of fact, it is perfectly well known that the images formed upon the retina lead to certain stimulations of the optic nerves ; that these pass backwards from the two eyes to certain intermediate cells near the under-surface of the brain ; that from these there pass new fibres, which convey the nerve impulses right through the substance of the great brain or *cerebrum*, to its hindmost part, where the vision centre lies.

Everyone's veritable eyes are thus in the back of his head. Somewhere in the wonderful cells of the vision centre, which lie in the grey matter covering the occipital lobes at the extreme posterior aspect of the brain, these nerve impulses are appreciated in the form of vision. There is no one standing and looking at the inverted images upon the retina. No terms of space, up and down, right and left, are applicable to the actual act of vision. As long as the retinal images show a consistent correspondence to external reality, the perceiving subject is not deceived. It matters absolutely nothing to him whether the image of a man standing on his feet is erect or inverted, provided that it is always one or the other, so long as the man stands on his feet, and is always reversed if he stands upon his head. All this may seem very mysterious and inexplicable, but the reader must try to believe that this is not our fault. Every fact of consciousness is ultimately mysterious and inexplicable, but the mere fact that we see things upright when the images of them on the retina are inverted offers no difficulty at all to anyone who has once grasped the fact that the act of conscious perception cannot be subjected to terms of space — terms derived from the physical world.

Self-education. And here we may be permitted a brief digression. It is commonly but blindly supposed that the function of a teacher is to instruct, to impart facts, to disseminate knowledge. But this is not so. Every teacher who has any real title to the name is not an instructor, but an educator. We may, indeed, hope that the reader has not gone so far along the courses which this publication provides for him without discovering the difference between instruction and education. If space availed, we might write a whole chapter—a chapter which we believe would be of real value—upon the title of this publication. It might have been called and conceived "The Instructor." In such a case the writers would have spent their time in setting down every fact they considered valuable in the best possible order, for the purpose of making them easily memorable. Many publications of this kind exist, and have their valuable function. One cannot do without a dictionary, an atlas, a gazetteer, and so on. These are all necessary instructors. No publication could properly be called a self-instructor, since one cannot instruct one's self.

The Business of a Self-educator. You cannot evolve facts out of your own inner consciousness, or at least any facts save those of your consciousness itself. But while a self-instructor is impossible, a self-educator is possible, and is the only possible educator. No one is self-instructed, not even the wisest. Even if he be a discoverer and a pioneer, Nature is his instructor. But every educated man is self-educated, and there is no other kind of education. All that the true teacher can do, or wants to do, is to help a man to educate himself. For this purpose the teacher must also be, up to a point, an instructor. But if he be really an educator he does not impart facts for their own sake at all ; he uses them merely as illustrations, merely as arguments in favour of the views which he lays before the reader, and which he asks the reader not to accept, but to consider for himself. Of course, we all have to take the greater part of our beliefs upon authority. Whenever possible, the present writer quotes the exact words of the workers who have first demonstrated the facts which he discusses. But none of these workers wishes his words to be accepted on his authority. There is no authority but truth. If this were an "Instructor" we might ask the reader to accept certain statements here made on our authority, just as he accepts the spelling of a word on the authority of a dictionary. But this is a *Self-educator*, and the reader will not pay us the compliment we most desire if he quotes any assertion and says : "It is so stated in the SELF-EDUCATOR." If this publication is to be worthy of its name, it must not merely teach the reader certain accepted facts, as any instructor might do, but must teach him to think for himself as only an educator can do, and must thus justify its title of SELF-EDUCATOR.

Real Education. The present writer has kept these principles firmly before him from the first. Again and again he has deliberately sacrificed the statement of facts of greater or less importance in order to gain space for attempts to be suggestive and stimulating, or even irritating, to the reader's own thinking apparatus. It was, and still is, the practice of one of the writer's teachers to ask his class an interesting question and deliberately decline to give the answer. Weeks or months later he turns suddenly upon one of his students and demands the results of his thoughts on the subject. So much the worse for him if he has

not thought about it at all. This is real education, not a cramming of the mind with facts, but a drawing forth of its own inherent powers. Such a plan can scarcely be adopted in a written work, but one is often tempted to try to do so.

Teaching to Think. The subject which has led to this long, but we hope not useless, digression, is a case in point, and the writer has more than once been successful in causing an intelligent boy to think it out for himself. Draw a simple diagram of the eye for such a boy, show him how the image of every object of vision is necessarily upside down upon the retina, and ask him how in the world it happens that we nevertheless see things right side up. If you have interested him and he tries to think it out, you will find that there first of all suggests itself to him the explanation to which we have referred—the idea that the experience of other senses, such as that of touch and hearing (in the case of the image of a speaking individual), enables us to correct the erroneous impressions derived from the retina. When this explanation is offered, reply that he is right to have thought of it, but that observation has shown it, as we have seen, to be inaccurate. Ask him to "think again," and tell him a little more of the paths of vision that lie outside the eyeballs altogether. Then very likely he will come to realise that he must revise his whole manner of thinking and must not imagine the perceiving mind as a sort of material shape, standing and looking in a certain position. If he still retains the notion that the perceiving mind is a kind of very minute man standing upright and looking at the inverted image upon the retina, ask him why, for all he knows, this little man should not himself be standing on his head, in which case the inverted image would be righted. This is the suggestion which the present writer has found most effective in removing a difficulty of understanding which at first seems insuperable.

We need not further apologise for reminding the reader that this publication is not an instructor but a self-educator, and that our business is therefore not to instruct the reader, but, if possible, to help him to educate himself. We may quote from the words of Sir Norman Lockyer, formerly President of the British Association, and now president of the recently formed British Science Guild, the object of which is to bring home to a sleepy public the importance of true science and of true education. Sir Norman says: "One thing we are agreed upon is the necessity of the best system of education both for the school and the workshop—that is, instead of instruction, learning things by rote, we want *education*, teaching men and boys to think. Instruction is often the bane of education."

Images in Several Mirrors. And now, after a digression for which we have long sought an opportunity, let us return to the Formation of Images.

Various interesting complications arise if more mirrors than one be used, but however much the images be multiplied, the laws of reflection are always accurately observed. Says Professor Tait, in reference to a phenomenon which some readers may have seen amusingly illustrated at a recent Earl's Court exhibition:

"The principles already stated suffice fully for the explanation of the curious vistas of images formed by two parallel plane mirrors facing one another at opposite sides of a room. The only additional observation necessary on this subject is that, if the mirrors are silvered on the back, the light at each reflexion has to pass twice through the glass. Thus, if the glass be pinkish or greenish, the various images are more and more coloured as they are due to more numerous reflexions."

The Kaleidoscope. There is a celebrated scientific toy, invented by Sir David Brewster about the year 1815, which illustrates the principles of reflection in two or more mirrors; this is known as the kaleidoscope. We need not go into the details of its mechanism, since they illustrate no new principles. It consists essentially of two plane mirrors which are inclined to one another at an angle of 60°, this being taken as the most convenient fraction of 360°. It can be proved that, in order to form a symmetrical picture, the angle at which the mirrors are inclined to one another must be an exact submultiple of two right angles; or, in other words, an even submultiple of 360°. If the angle between the mirrors does not conform to this, a symmetrical figure cannot be produced. If it does, a symmetrical picture is yielded by objects placed in any position between the mirrors.

In the ordinary kaleidoscope the mirrors consist of two long strips of thin glass inclined at the requisite angle to one another, and placed within a cylindrical tube, through one end of which the observer looks, while at the other end is a box with glass walls containing pieces of coloured glass, etc., placed so as to lie in any position between the mirrors. Since reflection is never perfect, the various sectors, or parts of the symmetrical picture, produced are not equally bright, but this does not detract from the beauty of the patterns.

In order to study the theory of the instrument a kaleidoscope may be formed in such a fashion as to permit of alteration at will of the angle between the mirrors. It can then be shown that it is necessary, as may also be proved by abstract considerations, for the angle between the mirrors to conform to the condition we have named.

Similar pictures may be produced by three mirrors, enclosing a triangular opening. They must be arranged so that each angle is an even submultiple of 360°; while, of course, if they are to be arranged in a triangle, the sum of the angles must be equal to two right angles or 180°. Three such arrangements are possible. If four mirrors be used they must be arranged in the form of a square, or at any rate a rectangle. Kaleidoscopes cannot yield regular figures with more than four mirrors, since the angles which would then be made between them could not conform to the necessary conditions.

Continued

TAILORING FOR MEN

The Start. Choosing Material. Style, Measurements, and Tools. The Drafting. Materials Required. Stitches. Stretching and Shrinking

By W. D. F. VINCENT

THERE are at least three distinct courses of study that have to be taken up by the young man who aspires to be a thoroughly qualified master tailor. He requires a knowledge of the practical or sewing part, the scientific or cutting part, and the commercial or business part.

Some little difference of opinion exists as to what is the proper order in which to take these. The old method was to serve a long apprenticeship to the sewing, then take lessons in cutting, and leave the business side to be picked up by actual experience—a plan which often led to the Bankruptcy Court, despite considerable technical ability. The more modern plan is to enter an academic course at some such institution as the "Tailor and Cutter" Academy, and there take lessons in all three sections simultaneously.

Assuming the customer has presented himself, the first step is to take the order, and here the skill of the tailor begins.

Selecting the Material. The material should be in harmony with the requirements of the customer, bearing in mind his occupation, form, and complexion. For wear-resisting purposes, cheviots, tweeds, and serges may be recommended; for dress garments, thinner, softer, and finer finished cloths are best. For business and professional wear, black coats and vests, and neat, striped trousers are generally most suitable. For farmers, builders, etc., neat drab tweeds of rather a heavy make, and not too rough, are the most appropriate.

For sportsmen, Harris tweeds and checked cheviots are very popular, and make up into stylish garments. Stout men should be dressed in dark colours, and plain or very small-patterned cloths. Checked cloths make men appear wider without increasing the appearance of height in proportion; and if checks are woven irregularly, as is sometimes the case, they give a lopsided effect which is anything but attractive. Stripes, whether in the pattern of the material, or produced by seams, stitchings, braidings, etc., add to the length or width of the figure in the direction in which they run.

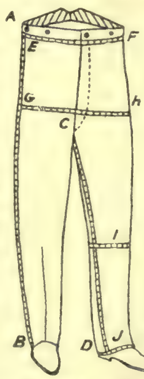
Dark complexions are best suited by those shades in which reds and yellows play an important part—as, for instance, russet brown, drab, etc. Fair people are best suited by blues, and those shades in which blue plays an important part.

Sell your customer material adapted to his requirements on these lines, and then proceed to get particulars of style.

The Style. This includes the shape of the garment and its general finish, and here the tailor will receive great assistance from fashion plates.

Do not attempt to put a man with old-fashioned ideas into the latest cut; discretion, tact, and judgment must be exercised, or the result will be bad. Find out what your customer wants, and then advise him judiciously; and having determined the style, carefully book the details of his order as it relates to pockets, time for trying on, finish, price, etc., together with the number of the material, and then proceed to take the measures, beginning with the trousers.

Measurements. A to B, full length of side, say, 44; C to D, full length of leg, say, 32; E to F, circumference of waist, say, 30; G to H, circumference of hips or seat, say, 36; I, size of knee required, say, 18; J, size of bottom required, say, 17 [1].



1. MEASUREMENTS

It is seldom wise to give less than 12 in. extra length to the side than the leg. Avoid taking the waist measure tightly. Take the size of seat in harmony with your customer's idea of fit.

Cutting Tools. We now take our cutting tools—*viz.*, inch tape, square, chalk, shears, and, if possible, a trouser stick. Take the cloth from which the garment has to be cut, notice if there is a way of the wool, and if so arrange for the pile to run down. If there is a string in the selvedge, it indicates a flaw in the cloth which must be avoided in the cutting. [This point will be dealt with more fully later.] The cloth is cut double, and in order to cut for the right and left sides this is arranged face to face. As a rule, trousers are drafted direct on the cloth in this way:

The Drafting. 1—2, the selvedge edge of cloth; 1 to 2, the length of side = 44; 2 to 3, the length of leg = 32; 3 to 4, one-sixth seat = 6; 2 to 9, one-fourth bottom = $4\frac{1}{4}$ [2].

Draw line from 9 to 4, and by it square across to 3. Square by line 4 to 9 across to 6; 4 to 5, one-twelfth seat = 3; 4 to 6, one-sixth seat plus $\frac{1}{4} = 6\frac{1}{4}$. Square up from 5 by line 5 to 3 (which is at right angles to line 4–9). Square across from 7 to 1; 13 is one-sixth seat plus 4 in. up from 5 = 10; 13 to 14 one-fourth waist plus $\frac{1}{2}$ in. = 8 in.

Spring out a little above 14, and round out to side line about 3 or 4 in. up from 3; 4 to 8, half leg length less 2 in. = 14; 8 to 10 and 8 to 11 are each one-fourth knee = $4\frac{1}{2}$; 9 to 12, one-fourth bottom, less $\frac{1}{4}$ in.

Complete outline of top sides as shown. Hollow over the fronts about $\frac{3}{4}$ in. for a 17

bottom, more for a smaller and less for a larger bottom.

The top sides are then cut out, a "turn-up" of from 1 in. to $1\frac{1}{2}$ in. being left at the bottoms. The "dress" is cut out from the right side as follows: 6 to 15, 1 in., curve up to fly line and down to leg seam as shown.

THE UNDER SIDE. Lay down the cut-out top side and proceed as follows:

6 to B, $1\frac{1}{2}$ in.; 10 to C, 1 in.; 12 to D, $1\frac{1}{2}$ in.; 5 to A, one-fourth seat less 1 in. = 8. Draw line from 6 through A [3].

13 to 14 and F to G together equal half waist plus $2\frac{1}{2}$ = $17\frac{1}{2}$. L to M and H to J together equal half seat plus 2 = 20.

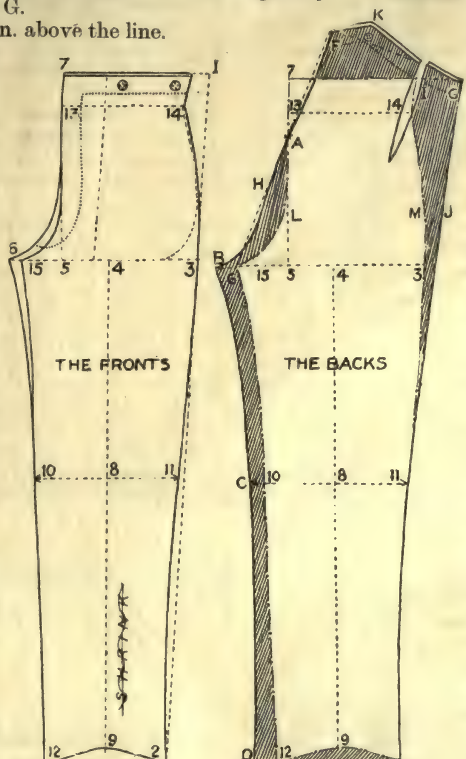
Square across from 1, then place square on seat seam and square across to G.

F. to K, 2 in.; K is $1\frac{1}{2}$ in. above the line.

Take out fish 1 in. wide, about 3 in. from G and about 6 in. deep.

Cut from the cloth, leaving from 1 in. to $1\frac{1}{2}$ in. inlay at the bottom for turn-up, about 1 in. up the side seams and 1 in. up the seat seam for inlays. Some also leave an inlay at the top of leg seam. Snip the side seams of top and under sides at knee on both leg and side seams to facilitate their going together fairly in the making up. Put sufficient cloth in to make pocket facings, fly, etc., and proceed with the trimmings.

Materials for Trimmings. $\frac{5}{8}$ yd. pocketing; $\frac{1}{4}$ yd. silesia to match; $\frac{1}{8}$ yd. linen to match; $\frac{1}{8}$ yd. striped silesia for waistband lining; $\frac{1}{8}$ yd. canvas; 7 large and 5 small buttons; 1 yd. of twist to match; a skein of silk; trouser binding, 6 in. over the waist measure; sundries according to details of order.



TROUSER DRAFTING

Stitches. In the making up of trousers, we have to consider the various stitches used.

THREAD-MARKING. Take a fairly large needle and thread it with a long thread of basting cotton, double. Take the part to be "thread-marked," see that it lies fair, and then put in long stitches exactly along the line wherever there is an inlay. Cut between the two stitches and pull the thread along so as to leave only sufficient cotton for the purpose as shown in **4**; now separate the top layer from the lower, and cut through the stitches, thus showing the exact quantity of inlay on either side.

BASTING. The basting stitch is simply a long fore or running stitch, and is used to put the various parts together previous to the machine stitching. This is known as tacking by dressmakers, and is illustrated on page 150. The basting stitch shown there is a form of this stitch, which is used for keeping two or three layers of materials in place.

BACKSTITCHING. This is the most important stitch used in tailoring, as well as the strongest. The thread enters the cloth at 1, travels through to the other side and up at 2, it enters again at 3, and comes out at 4, enters at 5, and comes out at 6, enters again at 2, and so on, the full length of the seam [**5**].

BACK AND FORE STITCHING. This stitch is used when it is desired to get over the work speedily. It consists of one back stitch and one fore stitch, alternately; thus it enters at 1, comes out at 2, goes back to 3, comes out at 4, goes on to 5, comes out at 6, and then goes forward to 7, out at 8, through to 9, and then back to 7, and so on, as indicated by the arrows [**6**].

FELLING. There are various styles of felling, one being that shown on page 150; the form generally used by tailors is that shown in **7**. The needle is inserted in the under material quite close to where it has come out on the upper material; it is then brought forward the length of one stitch and brought close to the edge of the upper material, thus enter cloth at 1 close up to the lining, come out of lining at 2 close up to the cloth. This is used for securing lining, etc., to the main part of the garment.

TACKING. Various forms of this stitch are used by tailors; we merely give the style mostly used for pockets. It is generally done with twist. First put in at least three stitches over and over, of sufficient length, say, $\frac{1}{2}$ in. to $\frac{3}{4}$ in.; this goes through cloth and linen, and its object is to make a very secure ending to the pockets. The long stitches being put in, proceed to bring up the needle close to the end of the tack, then put it through on the other side of the twist, and so hold it down; repeat this as regularly as possible until the entire length of the tack has been covered with these over and over stitches [**8**].

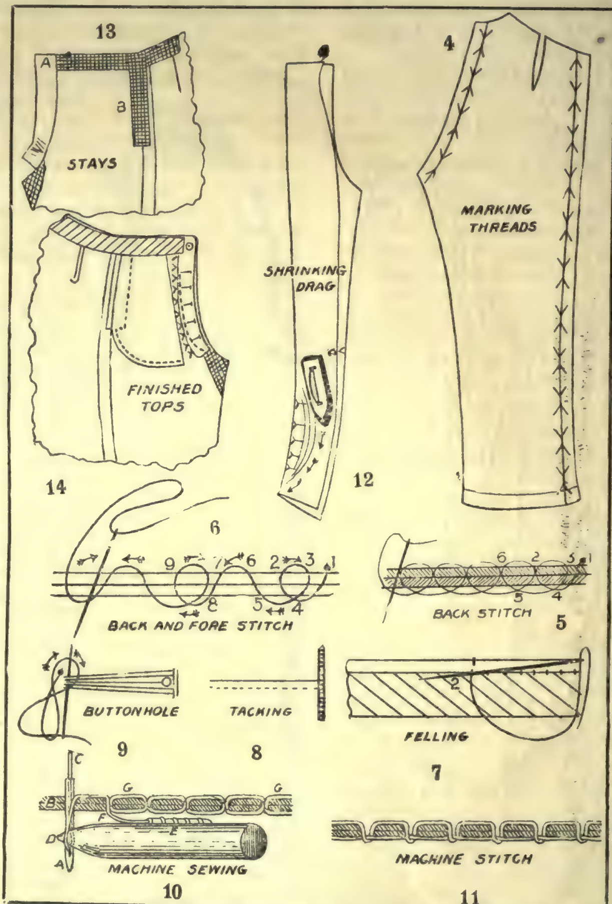
BUTTONHOLE STITCH. The buttonhole being cut of the correct length, first put in a bar thread either of gimp, four-cord thread, or double twist, as shown by the double line. Now start from the left-hand end of the top side, insert the

needle close up to the end, and then bring the twist up and cast it over the needle from left to right, and draw the needle up at such an angle as will raise the "purl" the desired amount. The stitches in a buttonhole should be regular both in depth and width, and the hand should always be drawn up at the same angle so as to retain regularity of "purl." The stitches at the eye may be a little closer together, and the "purl" brought a little higher than the other parts. The end of the hole is finished with three over-and-over stitches and three "purl" stitches just over these; they are then drawn together and pressed, the edges being *bitten* up to make a good finish [**9**].

Machine Sewing. Of the various kinds of stitches made by sewing machines, the lock stitch alone needs comment. The machine stitch is made by the twisting or interlocking of two threads, and great care is necessary in the adjustment of the tensions of the two threads to ensure getting the machine stitch at its best. It is illustrated in **10**. C is the needle, with eye near the end, carrying a thread A. B is the double thickness of cloth to be seamed, D is the nose of the shuttle with thread coming out of the top at E, F shows the last completed stitch, the tensions being arranged so as to cross exactly in the centre of the two layers, thus ensuring the most possible elasticity. In **11** we show how the stitch is formed when the lower tension is tight or the top much too loose, the result being that the least strain snaps the thread, and the stitches go. A good stitch appears the same on both sides.

Stretching and Shrinking. The peculiar formation of the wool fibre enables the tailor to stretch or shrink different parts of the cloth by the use of moisture and a hot iron. This is employed in various parts of garments, but in trousers it is principally used at the bottom of the top sides and the thighs of the under sides. The principle is the same wherever it is used. Fold the cloth over at the part to be shrunk, wet it, and then bring it round so that the cloth forms puckers. Then apply a sharp iron, and work it round as shown by the arrows on **12** until the form desired has been imparted. The under part shrinks most, and to get both sides alike it should be turned over and the operation repeated.

The Making. First mark up the inlays with marking threads, then shrink the bottoms—some tailors do this before they are seamed, others do it at a later stage. Put in the stays for the pocket in top side, and stitch the mouth about 6 in. deep. Put a piece of linen on the fork of top side [**13**]. Now baste the seams, keeping the balance marks together; seam them together either by hand or machine, but always seam five or six inches down from the top of leg by hand; press open the seams and put linen stays on for the pockets at B, at the back of the facings that have been sewn on at that part. Put canvas round the top, as at A, seam on the button-catch on the right side to within 2 in. of the fork, and put linen down the back of this to take the buttons.



4—14. DETAILS OF TROUSER-MAKING

Now make up the fly, and line the front at that part of the left top side with silesia. Work five buttonholes as marked in **14**. Baste up the fly, make up and put on the pockets, having tacked the top and bottom. The pocket is felled to the facings of the top side, and to the linen and facing of the under side. Stitch on the fly and continue the stitching round the tops. Bind the tops, press them, and sew on the buttons. Close the seat seam and tack the fly with some neatly "pricked" stitches. Press the seams, put on the waistband and crutch linings, and then turn up the bottoms, making the length of leg to measure. The trousers are now ready.

Continued

UNITY OF THE BRITISH ISLANDS

The Celtic Fringe. A Survey of the Beginnings and Evolution of the Peoples of Scotland, Ireland, and Wales. Their Rulers and Early History

Continued from page 2359

By JUSTIN McCARTHY

IT is time that we should take some account of the countries which have been, almost as far as authentic history goes back, regarded by the world in general as associated in locality, in dealings, and in destiny, with the history of England. We may begin with Scotland.

Scotland. We learn something of this region from Roman records and especially from the writings of Tacitus, the Roman historian, who died nearly a hundred years before the Christian Era. The Romans gave the name of Caledonia to that part of Scotland which was north of the Wall of Antoninus. More recent accounts, some of them recorded by the Venerable Bede, tell us that this region was made a place of settlement by an invading tribe from Ireland, who gave it the name of Scotia. The earliest invaders of Caledonia appear to have been Celtic tribes called the Scuths, or Scythians, who were later known as the Scuths or Scotti. The Scotti, who passed to Caledonia from some parts of the coast of Gaul, drove the Caledonians and the Picts, who are by some historians said to have been the earliest inhabitants of Scotland, into the north of the country, and according to these authorities it was from the names of the invading Scotti that the inhabitants of that part of the country, and afterwards of the whole of the northern region, came to be designated Scots.

The Romans under Agricola invaded Caledonia some eighty years after the Christian Era; and the Wall of Antoninus was built to secure the Roman conquests at a later period.

The Scottish Line of Kings. We may pass rapidly over these early developments of Scottish history. The Norwegians invaded Scotland; the Danes also made invasion but were finally driven out. The Northern Scots had kings of their own. One of these was Duncan I., grandson of Malcolm II., whose name has been made to live for all time, not by chronicle or history, but by the drama. Duncan I. was murdered by a kinsman of his named Macbeth, whom Shakespeare has made immortal. Macbeth was, according to chronicle as well as to Shakespeare, defeated by the rightful heir to the throne who had the assistance of Edward the Confessor, and Macbeth himself was killed by Macduff at Dunsinane. The battle of Waterloo is hardly more of a reality to the modern mind than this struggle at Dunsinane has become through the genius of England's greatest poet.

There were many struggles afterwards between England and Scotland, and the Scots resisted for a long time the attempt of the English sovereigns to make one common kingdom of the two countries. The English language began to spread itself through the southern parts of the Caledonian region, and the south of Scotland appeared to be fairly on the way to incorporation with the north of England. For a time, indeed, it seemed as if the tendency were for Scotland, as a whole, to accept the overlordship of the English rulers according to the system which, as we have already said, prevailed for the time between the most powerful monarch of England and each of the minor sovereigns, who still claimed rule over separate dominions. Scotland came, however, before long to establish a royal line of sovereigns whose supremacy was generally acknowledged among the Scottish people.

English Settlement in Scotland. Malcolm III., known as Malcolm Canmore, the eldest son of the Duncan whose reign was brought to an end by Macbeth, proved himself after the defeat and death of the usurper to be one of the most powerful and most beneficent rulers Scotland had ever known during her existence as a separate kingdom. Malcolm came to the throne in 1057 A.D. He had lived for a long time in England, had married an English Princess, Margaret, the sister of Edgar Atheling, and this marriage led to the settlement of a large number of English residents in Scotland; to the spread of English commerce and the English language there, and to a friendly feeling, for the time at least, between the people of the two countries.

This tendency of Englishmen to settle in Scotland and to spread their trade, their business, and their language there was much increased by the many severe and almost despotic measures introduced by William the Conqueror into his English kingdom with the support of his Norman followers, measures which, as we have already seen, were felt to be oppressive in many parts of his dominions.

Malcolm III. Malcolm Canmore appears to have been a man of generous character, with an understanding much in advance of most of the rulers belonging to his day. It was his constant endeavour to maintain, as far as possible, the national usages of his country, and to promote the love for music and poetry, and culture in general which have always been characteristic of the different varieties of the Scottish race. He had also a strong desire to mould those different varieties of the people into one common nationality, and to maintain Scotland, according to its limits as then marked out, as one distinct and independent kingdom. In all his plans he was greatly assisted by the generous efforts, the attractive ways, and the thoroughly noble

nature of his wife, who since she had become a Scottish Princess proved herself ever sympathetic with the Scottish people and their traditions. Wars were still frequently going on in those disturbed days; Malcolm himself was killed on the battlefield in the year 1093, and his wife survived him only by a few days. After their deaths the country, for a while, seemed to be growing more and more under English influence, but the union of the two kingdoms was yet very far off.

The Evolution of Caledonia. We shall tell during this course how the intervening period was marked by a succession of fierce struggles between the Scotch and the English, and how it brought to the front some illustrious Scotchmen, kings and military leaders alike patriotic, whose names will live for ever in history. For the present our purpose is to trace the gradual emerging of Caledonia from its dawn, through its legends and its traditions, into the clear light of distinct nationality and established historical record. An atmosphere of the poetic, and in a certain sense of the artistic, prevailed throughout the story of Scotland from its opening page. The physical character of the country, with its high mountain ranges, its lakes and its rivers, its caverns and its woods, all compressed into such narrow compass by the imprisoning waves of its great surrounding seas, seemed to mark it out as the natural home of the legend, poetry, and romance. For a long time its literature and romance, its poetry and its prose were mainly appreciated in Scotland itself, and were but little understood across what was then regarded as the English frontier. There was, indeed, a much closer sympathy between Scotland and Ireland, between Scotland and France, and even between Scotland and some parts of Germany—of the Teutonic races, that is to say—than between the Scottish people and their English neighbours. At the time which we have now reached in this history there were merely evidences—and only in its later days—prophetic of the great change which, after many fierce interruptions by warlike struggle, were to unite the two peoples under one crown and one state system.

The Story of the Irish People. The opening of the history of Ireland opens also the story of a race which for centuries seemed little likely ever to come into congenial union with the people of England. In the case of Ireland, as in that of Scotland, we have to rely on legend and tradition for much of the story which is now commonly and reasonably accepted as authentic, reasonably because what we learn from legend and tradition shows itself in full accordance with the national development described in genuine and authoritative record. The Irish people, like the Scotch of the Highlands, like the peoples of Wales, of the Isle of Man, and the northern parts of France, appear to have been of Celtic origin. But we have a large amount of literary lore in Ireland which would take us back to a still more distant age of the world's development. One of the treasured legends of Irish traditional lore is that which tells that the Phœnicians from the coast of Syria, the great navigators and explorers in the dawn of history, were the first strangers who made a settlement on the Irish soil.

Greek Settlers in Ireland. Another story tells that Ireland was occupied by a whole colony of settlers who came from Greece and are even now known in Irish history as the Tuatha de Danaan, a name still familiar and treasured in Irish romance and even in Irish history. This Greek race is said to have made its home in Ireland for many centuries. Of course we are not bound to accept this legend any more than that of the Phœnician settlement as a distinct and authentic part of Ireland's developing history; but it may be safely said that when such legends become part of the common belief of a people the probability is that they must have had something of reality to impress them thus on the national memory. Even the most practical historians see reason to believe that much in the national characteristics of the Celtic Irish during past centuries, and, to a certain extent, down to our own time, suggests the probability of an ancestry coming from some sunnier region than that of Ireland itself. The habits of the Irish peasant even in our own day suggest that he must at some time, however remote, have had an ancestry coming from a land where life was mainly passed in the open air.

The early literature of Ireland is saturated with ideas which seem to belong to lands where the supernatural and the miraculous are familiar to the life of the human being; and its popular story-telling concerns itself almost unceasingly with fairies and goblins, with supernatural visitations, and with haunted rivers, lakes, caverns, and mountain-sides.

The Milesian Masters of Ireland. As we follow the history of Ireland's development, we are told that the island was occupied by the Milesians, a people of eastern race who had been settled for a long time in Spain, and were in the course of their adventurous career taken by the desire to make themselves owners of Ireland. They invaded the island, defeated finally the descendants of the Phœnicians and Greeks who were still rulers there, and made themselves masters of the land. Then there came, according to this still legendary history, a struggle between two of the leading Milesian chiefs which ended in one of them killing the other and then declaring himself king of the whole country. The Milesian sovereigns who succeeded this first ruler are said to have been 118 in number, and a large amount of early Celtic literature, both poetry and prose, is devoted to their reigns.

Gradually we come to the Ossianic legends which tell of the adventures of Fingal, or Finn, as he is called more habitually in Irish story. In due course of time the Irish people seem to have divided themselves into a sort of communistic rule under the leadership of a number of elected chieftains, or sovereigns, and with a Druid priesthood, who before the days of Christianity undertook the religious teaching of the

people—a religious teaching proclaiming somewhat vaguely the existence of a ruling spirit, the personality of which was typified for mortal eyes by the presence of the sun. The population was for a long time divided into septs or clans, the chief of each sept recognising the predominant authority of the chief elected to reign over the whole island. The Brehons, as the official judges and expounders of the laws were termed, were, as well as the chieftains and even the sovereigns, elected to hold their position. The authentic history of Ireland may be said to have begun with the time when Christianity took possession of the island.

St. Patrick. The first great name which comes up in Irish history after Christianity had begun to spread itself over the world is that of St. Patrick, the patron saint of the island. Patrick is said to have been, in his early youth, sent as a slave from Gaul into Ireland, having been captured by pirates engaged in the slave trade of those days. Even during his time of servitude he appears to have conceived a great affection for the Irish people. Long after, he made his escape to France, and from there to Rome, where he rose to a high place in the Christian Church. He returned to Ireland about the year 430 A.D., and began to devote himself to the teaching of Christianity there. Later on Ireland was invaded by the Danes, a race who, at that period, made themselves famous far and wide by their many daring and successful enterprises in invasion. The Danes were the rulers of Ireland for more than a century. Their rule came to an end, as most such foreign settlements do, by the rise of the one man whom nature seems to have destined for such a work. This man was Brian Boroihme, or Boru, brother of the king or chief of Munster, the southern division of the island, one of the most popular men in the country, whose name has given birth to a whole literature of history, romance, and poetry in Ireland. Brian had the genius of a soldier as well as of a statesman. He organised an army in 968 which completely defeated the Danes. That defeat was followed by another and another until the Danes were at last brought to a condition which made them willing to accept for the time the terms of the conqueror, and to content themselves with living in certain of the seaport towns, where residence was permitted to them so long as they made no effort at the reconquest of territory.

Brian as Ruler. Brian became convinced that his country would do better if united into one state under the rule of one sovereign than it could do under the rule of the separate chiefs. The whole course of his career fairly justifies the belief that his opinion was guided in this matter by purely patriotic considerations, and not by any ambitious desire to be raised to the rulership of the whole country. But this elevation naturally took place, amid the enthusiasm of the whole Irish people. Brian proved himself a wise, and, in every sense a most admirable ruler. He maintained peace and order throughout the whole land, and Irish literature is full of legends and poems which tell of the marvellous security prevailing throughout the whole island during his rule.

Brian had twelve years of a peaceful reign, then a rebellion was organised among those of the Danes who remained in Ireland, and the result was another invasion, Denmark seeking once again to conquer the island. Brian was now growing old, but he soon proved that he had not lost his courage and the military genius of his early days.

Ireland Divided into Provinces. He stirred up the whole country into energetic measures of defence, and took command of the forces himself. On the battlefield of Clontarf, ever since famous in Irish history and romance, he encountered the Danish army on Good Friday, 1014 A.D., and inflicted on it so crushing a defeat that it put an end to all peril of any further invading expeditions from Denmark. The battle was not gained without heavy sacrifice to the Irish cause, for Brian himself was killed after the struggle had long passed its turning-point. Brian, who was always careless of his own safety, assumed too hastily that the danger was all over when he had seen the Danish troops disperse in flight. He was recognised and killed by the Danish leader in his own tent, where he had gone to offer up a prayer of thanks for his country's victory. His death was in every sense a heavy loss to his country, for there was no one to succeed who could maintain supreme dominion over the whole island.

Ireland was once again broken up into four separate divisions, the provinces which we now know as Leinster, Munster, Connaught, and Ulster. The rulers of each of these divisions, while professing a nominal allegiance to the sovereign chief, governed their own states according to their own ideas, and there followed an era of civil war. Dermot Macmurrough, King of Leinster, carried off the wife of the Lord of Brefny. Brefny made war upon his betrayer, and Rory O'Connor, the last king of Ireland, espousing his cause, Dermot had to fly the country. He hastened to Acquitaine, where Henry II. of England then was, and doing him homage, asked his help. In response to his request some of the Norman barons, under the famous "Strongbow," invaded Ireland. Eventually, Henry II., becoming impressed with the idea that he was aiming at rivalry with him, recalled Strongbow, who returned to England and came to an understanding with the king. The result was that Henry himself led a great army into Ireland and, subduing all resistance, made the country a conquered part of his dominions. The history of Ireland is, from that time, associated with the history of Great Britain.

The Early History of Wales. Our course now brings us to the history of Wales. The Welsh people were known in the dawn of history as the Cymri, the word meaning "fellow countrymen," and the Welsh country was called by the Romans "Britannia Secunda," the words Welsh and Wales being merely gradual corruptions of phrases used by conquering invaders—Teutons

especially—to describe anything foreign to them. After the Roman occupation of Britain had come to an end under the Emperor Honorius, Vortigern was elected king of that part of Great Britain which came more lately to be distinctly designated as Wales. Vortigern, as we already know, is said to have invited the Saxons into Britain to help him against the Picts and Scots, but the Saxons made use of this invitation in order to become masters of the whole of South Britain; and to carry out this work of conquest they obtained the assistance of reinforcements, of which the Danes constituted an important part. In Wales itself a strong resistance was made, and many of the populations of South Britain found shelter there, assisting the Welsh to maintain themselves against all intruders. The nature of the country, with its mountain ranges and its easily-defended passes, enabled them to hold the Welsh territory against hostile invasion.

The British Invasion of Wales. Thus, from about the year 450 A.D., the Welsh were able to keep themselves in something like isolation, until Henry II. invaded the country in 1157 and put a great part of South Wales under the dominion of Britain. The long interval of isolation enabled the Welsh to develop their national characteristics, and to cultivate a literature and a music entirely their own. During that long interval the history of the country resolves itself mainly into struggles between the various princes or chiefs, who claimed dominion over some part of the land, and each of whom was almost always trying to extend his dominion at the expense of some neighbour's territory. There were also frequent struggles going on between Welsh chiefs and the rulers of border states on the English side. The border lines between England and Wales were but indistinctly marked, and gave rise to a variety of disputes ending in war.

Christianity found early recognition in Wales. The Welsh have been always regarded as a people who from almost the earliest Christian days were ever permeated by the religious principle, although divided on many other questions.

Union of England and Wales. The peculiarity of Wales's geographical situation made it all but impossible for her long to retain a position of actual independence. She was made up, for the most part, of races having no affinity with the early ancestry of the British people. The same has to be said of the Irish and the Scots; but Ireland was, at all events, a separate island, and the border-line of Scotland was much more distinctively marked in its position and its geographical construction than that which divided Wales from England. The early history of Wales in its struggles with England is therefore difficult to trace with precision.

In 1282, King Edward I. subdued the whole of Wales, and the death of Llewellyn, the last Welsh sovereign, brought the independence of Wales as a separate realm to an end. When all hope of further resistance on the part of the Welsh people had been abandoned by them, an agreement, known as the Statute of Wales, was devised by the conquerers and had to be accepted by the conquered. This statute proclaimed that "Divine Providence has now removed all obstacles, and transferred wholly and entirely to the King's dominions the land of Wales and its inhabitants, heretofore subject unto him in feudal right." The long struggle between England and Wales was marked by many brave and desperate efforts at resistance on the part of the Welsh, and a whole literature of picturesque and romantic incident has grown out of the events of those days. The Welsh people appear through all the vicissitudes of their history, and even long after the rule of England had been established beyond dispute, to have maintained their national character and the resolute independence of their national ways.

The First Prince of Wales. The son of Edward, who was born at Carnarvon Castle in 1284, was the first of the Royal English stock to whom was given the title of Prince of Wales.

With that event it may fairly be said that the history of Wales as an independent State came to an end. This does not mean that the nationality of Wales, any more than the nationality of Ireland or Scotland, became absorbed into that of England, or even that there were not many subsequent efforts to reassert the separate state nationality of each of these three countries; but only that there came a time when, for the historian, Ireland, Scotland, and Wales become parts of the kingdom of England, and that time was marked for Wales by the event which we have just recorded. Mr. Green, in his "Short History," tells us that "from the earliest moment of his reign Edward I. definitely abandoned all dreams of recovering the foreign dominions of his race, to concentrate himself on the consolidation and good government of Britain herself." Mr. Green goes on to say that "with the reign of Edward begins modern England, the England in which we live," and he adds that "it is not that any chasm separates our history before it from our history after it, as the chasm of the Revolution divides the history of France." But Mr. Green shows that the development of the four nationalities makes from that time, in literature as well as in political government, the movement of one great State.

The Isle of Man. Something has to be said in this course about the islands which, like Ireland, have been for centuries regarded as parts of the English Kingdom. The Isle of Man, of which there is no authentic history until about the sixth century, was, from that time, ruled by Welsh kings. Near the end of the ninth century it was invaded and annexed by the Norwegians, led by Harold Haarfager. The Norwegians, as we have seen, were ever in quest of new realms to conquer. Man was ruled by Scandinavian kings until 1266, when Magnus, King of Norway, ceded to Alexander III. of Scotland the possession of this much tried little island which seemed to have the fatal gift of ever attracting new invaders. On the death of Alexander the inhabitants of Man—probably feeling a desire to have their island occupied, if it must be occupied by strangers,

at least by strangers who were nearer to them in position and in ways than Norwegians or even Scots—invited King Edward I. of England to take possession of it in 1290. Under some such conditions the Isle of Man remained for a long time, being treated as if it were one of their own under the dominion of the over-ruling Monarch. The island passed into the ownership of the House of Stanley in 1406, when it was granted to that house in perpetuity. They were called Kings of Man until 1651, when the title was changed to Lord. The Isle of Man was held at times by other great houses under this singular method of proprietorship until at last the British Parliament found it more becoming and convenient to buy out the existing owner of the land, and to make the Isle of Man a part of the British Kingdom. This was done in 1765.

The history of the island contains many interesting chapters. In 1651 the Countess of Derby of that day held the island for a time against the whole strength of the Parliament forces. The first Bishopric of Man is believed to have been founded at a very early period in the spread of Christianity, and there are legends which maintain that St. Patrick was the founder of the See. The Isle of Man has an independent legislative body of its own called the Tynwald. It is composed of two Chambers, one made up of the Governor and the Council, and the other known as the House of Keys, whose acts receive the Royal assent. In many chapters of its history the Isle of Man is as picturesque as in its natural formation, and it has attracted much notice in romantic literature.

The Small Islands. The Channel Islands—Jersey, Guernsey, Alderney, and Sark—were invaded and occupied by the Romans and were thus held until nearly 400 years after the birth of Christ. Rollo, a leader of the northmen, captured the Channel Islands and afterwards constituted them a part of the Duchy of Normandy, a possession which he had obtained from the King of France ; but they were made part of England's kingdom by Rollo's successor, William the Conqueror. Alderney and the other Channel Islands were acquired for England by William the Conqueror at the same time—1066. The Hebrides, the western islands of Scotland, find frequent mention among early Roman writers, and were known to Pliny as the Hebudes. These islands were occupied for a long time by the Norwegians, but were yielded to Scotland in 1264, and formally annexed to the Scottish Crown by James V. in 1540. The reading world of modern days probably owes its chief interest in these northern islands to James Boswell's "Journal of a Tour to the Hebrides with Dr. Johnson," published in 1785, devoured at that time by the greedy admirers of everything that came from or had association with Samuel Johnson, and even still holding a place on the shelves of most of our libraries.

The Isle of Wight. The Isle of Wight has undergone probably more conquests and re-conquests than any other of those islands whose history we have just been summarising. It was invaded by the Romans under Vespasian, in the reign of Claudius, and was called by the Romans Vecta, or Victis. Then, when the strength of Rome was beginning to decline, the Saxons took possession of it, somewhere about 530 A.D. The Saxons held it in their keeping for nearly two centuries and a half, and it afterwards came into the possession of the Danes, who occupied it for a considerable time, then left it, but after a long interval made themselves masters once again and ruled it for another long period. The French took a fancy for it and made it their own in 1377, and, indeed, made several subsequent attempts to regain it; but after the Norman conquest it was brought under the dominion of the English Crown. Henry VI. assigned the rule of the island to an English Peer, whom he actually crowned King of the Isle of Wight, after the fashion of those days for the creation of minor sovereigns under the over-ruling monarch. Charles I. was a prisoner in Carisbrook Castle for some months before his execution. The island has many interesting remains of the past which are yet to be seen there. Near to Carisbrook Castle there still are the remains of a Roman villa, while the foundations of a much larger Roman building have quite lately been discovered, the pavements of which retain ample evidences of that Roman architectural art which prevailed in the classic days. The castle was strengthened in all its defensive works at the time of the Spanish Armada, and it is, indeed, one of the most interesting historical buildings of the distant past.

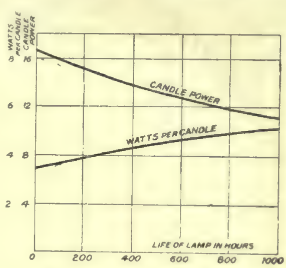
From this rapid survey of the story of our islands it will be seen what an intermingling of various races has gone to make up the populations which now form the centre of the British Empire.

Continued

Group 10 ELECTRICITY 18 Continued from page 2417	# GLOW-LAMPS
	Incandescence by the Electric Current. Manufacture of Glow-lamps. How the Vacuum is produced. Efficiency and Candle-Power. Use of Shades

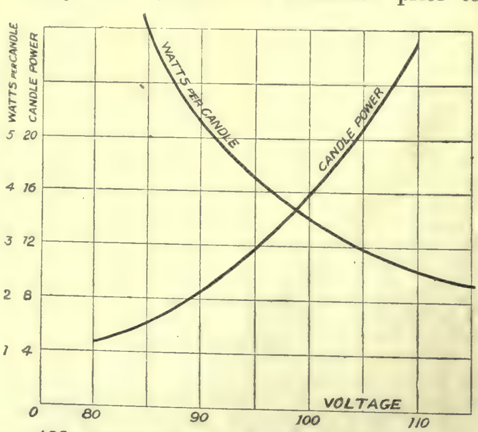
By Professor SILVANUS P. THOMPSON

IT was the introduction of the commercial incandescent lamp, in 1880–1881, that first called for the supply of electricity on a large scale from central stations. Years before, electricians had known that current passing through a thin wire would heat it, and that under certain conditions it could be made to glow, but the difficulty had been to find a substance which could be kept at a glowing temperature for great lengths of time without melting or becoming disrupted. Most of the metals were, of course, out of the question, because they melt soon after they reach the temperature at which glowing occurs, and the only metal which was ever used to any extent was platinum; but this was unsatisfactory, as with variations in voltage above the normal the melting temperature was too easily reached. The substance to which inventors then turned their attention was carbon, this having the highest melting-point known. The difficulties to be overcome were, first, to obtain it in the form of a fine wire or filament, and then to seal it into a globe from which the air had been exhausted, for carbon even at a red heat rapidly combines with the oxygen of the air to form the well-known carbonic acid gas. Early in 1879, Swan exhibited a vacuum lamp having within it a carbon wire only 1 millimetre thick. Within a few months this was superseded by lamps having thinner filaments made from thread or paper carbonised. To perfect the filament, many forms, including parchmentised cotton thread (Swan) and bamboo fibre (Edison), were tried; but at the present time all makers use practically the process briefly described in the following paragraph.



182. AGEING OF LAMPS

The Present-day Filament. Best bleached cotton-wool is dissolved in a warm solution of zinc chloride in water. The mass which results has the appearance of thick treacle, and must be freed from air bubbles and uncombined water by being placed in a vacuum. It is then squirted under pressure through a glass nozzle, and passes into a mixture of methylated alcohol and hydrochloric acid, whch removes all the water from the jelly-like thread. This thread contains the carbon which is going to form the incandescent filament, but it is at present in a state combined chemically with hydrogen and oxygen, and intimately mixed physically with zinc chloride. It is, in fact, a thread of celluloid. The next process is to wind this flexible thread upon blocks to give to the loops the shape which they will afterwards have in the lamp. The blocks are then packed tightly in boxes with charcoal dust, and the boxes containing them are subjected to a gradual and prolonged heating up to 2,000° C., during which the celluloid is transformed into a shiny and extremely flexible black filament, which is almost as hard as diamond.



183. EFFICIENCY AT VARIOUS VOLTAGES

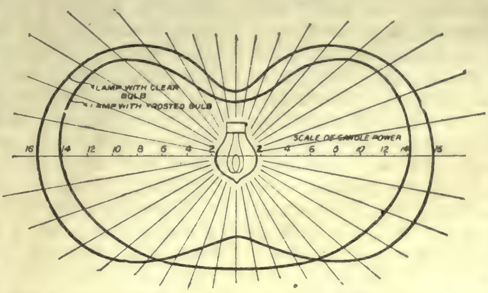
Flashing the Filament. The preparation of the filament is, however, not yet complete. We pass over the details of gauging and cutting, and reach the stage when it is almost ready to be inserted in the bulb. In order to make a final adjustment of the resistance of the filament, and also to thicken up any places of reduced diameter, it is mounted in a stand, a bell jar is lowered over it, and the air is exhausted prior to the introduction of a volume of a carbonaceous vapour such as that of benzine. On the filament being heated by passing current through, the vapour deposits some of its carbon upon the filament. If any part of the filament be smaller in diameter than the rest, this part, on the passage of the current, will be hotter than the other parts and so will receive a greater deposit of carbon. The filament is then ready to be sealed into the bulb. Some makers do not now use the flashing process, but simply standardise the filaments by careful selection.

Exhausting the Lamp Bulbs. Ordinary air-pumps never exhaust the air completely from a bulb, but leave a residuum. It was the invention of the mercurial air-pump by Sprengel,

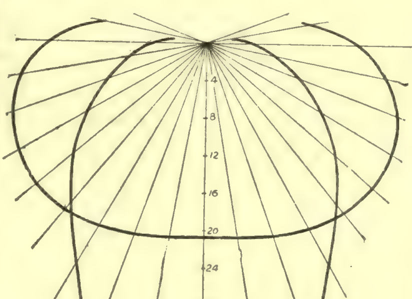
and its improvement by Crookes and by Stern, which enabled Swan to produce the first well-exhausted glow-lamps. For many years all glow-lamps were pumped out by mercurial air-pumps, because these alone gave results sufficiently near to a perfect vacuum. But about six years ago it was found possible to employ improved mechanical air-pumps, the last trace of oxygen in the bulb being subsequently removed chemically by the introduction into the lamp of a minute quantity of phosphorus.

Physics of the Incandescent Lamp. Considered from the point of view of energy, the incandescent lamp is a piece of apparatus for transforming electrical energy into light energy. As is usual in any transformations of energy, a certain amount goes to waste as heat. In the present case the energy which is wasted is many times that which is usefully applied, and consequently we may hope for very great improvements in the economical manufacture of light from electricity. By immersing a lamp in water and measuring the heat given to the water, it was found that from 4 to 5 per cent. of the electrical energy only had been turned into light, the rest being given out as heat.

The *efficiency* of a lamp is not, however, expressed in this way, but by the number of watts required to produce each candle-power of light that the lamp gives out. The energy we give to the lamp per second is measured, of course, by the current multiplied by the volts—*i.e.*, the watts [page 292]—while the amount of light is expressed by comparing it with a standard candle; and so the "watts per candle" becomes a very convenient way of expressing the quality of a lamp. When new, a good lamp should require about 3·5 watts per candle. Thus, a 16-candle power lamp will take about 56 watts, and if it is a 100-volt lamp the current required will be 0·56 ampere.



184. DISTRIBUTION OF LIGHT FROM INCANDESCENT LAMP



185. LIGHT DISTRIBUTION FROM SHADES IN 186 AND 187

Voltage, Candle-power, and Efficiency. In the manufacture the filament of a lamp has been so gauged as regards length and diameter that on applying at its terminals the voltage at which it is marked it will take such a current as will cause it to give out the candle-power at which it is rated. The quality of the carbon in the filament determines whether the lamp comes up to the required efficiency under these conditions. It is important to inquire what happens when the voltage applied to the lamp is more than that specified. With an increase of voltage we have a corresponding increase of current. This larger current will raise the filament to a higher temperature, and as carbon, unlike all the metals, has a negative temperature coefficient [page 671], the resistance of the lamp is decreased and more current flows, tending, therefore, to raise the temperature still higher. The rise in temperature is thus more than proportional to the rise in voltage. If to this we add the fact that incandescent bodies show very much increased amounts of light for slight increases of temperature, we shall readily understand that by a slight rise of voltage we may easily double the amount of light emitted by the incandescent lamp. As a matter of fact, it is found that the candle-power of a lamp is roughly proportional to the *sixth power* of the voltage—*i.e.*, if we increase the voltage at a lamp from 100 to 102 we increase the candle-power from, say, 100 to 100 × 1·02 × 1·02 × 1·02 × 1·02 × 1·02 × 1·02 (= 112·6), and we can double the candle-power by increasing the voltage about 12·2 per cent. As we are getting much more light for this small increase in current it follows that the lamp is working more efficiently. That this is so is seen from the following table, which is compiled from actual tests. A column giving the candle-power has also been added, and to give a better idea of these variations the figures have been plotted in 182.

Voltage at terminals of lamp.	Candle Power.	Watts taken for each candle-power.
80	4·6	—
85	6·3	7·0
90	8·5	5·3
95	11·9	4·24
100	16·0	3·5
105	20·7	2·9
110	27·2	2·5

The Ageing of Incandescent Lamps. The considerations in the preceding paragraph lead up to another point. If the lamps are so much more efficient as regards energy consumption when they are run at a higher voltage than that stamped upon them, why do we not run them at this increased

voltage? The reason is that all incandescent lamps, whether gas or electric, deteriorate with use, and this deterioration is the more rapid the higher the temperature at which they are used. The *life*, or the time during which an electric lamp will burn before breaking, when used at normal voltage, may be anything from 1,000 to 2,000 hours. During this time, however, the lamp is slowly losing its power and efficiency, and it may be advisable to discard it long before it would finally break. The deterioration appears to be due mainly to two causes: (1) a decrease in the conducting quality of the carbon, so that its resistance goes up and its surface becomes less powerful in emitting light; and (2) the few millions of molecules of gas still left in the bulb after the exhaustion process, in their violent to-and-fro movements, impinge upon the white-hot carbon, convey particles of it away and deposit them on the surface of the bulb. The decrease in power and efficiency is shown in the following table, from which curves in **183** are plotted. The figures are compiled from experiments carried out on forty-eight 200-volt lamps of various manufactures:

Time of burning in hours.	Candle-power at end of time.	Watts per c.p. at end of run.
100	15·9	3·81
200	15·0	3·98
300	14·3	4·13
400	13 7	4·29
500	13·1	4·45
600	12·6	4·60
700	12·2	4·72
800	11·8	4·88
900	11·5	5·00
1000	11·3	5·08

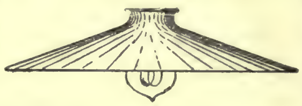
Deterioration of Lamps. Now, with regard to the increased efficiency at higher voltages, because the lamp is being used more violently, we should expect that the deterioration would be more rapid. Such is, indeed, the case, and it is found by experiment that a lamp run at 10 per cent. above its normal voltage runs for only about twelve hours. The following table shows very clearly the marked decrease in life which occurs when lamps are run at voltages which are within the voltage variations allowable in ordinary house supply:

Percentage of Normal Voltage.	Percentage of Normal Life.
100	100
101	88
102	68
103	56
104	45

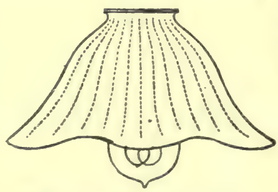
The table demonstrates that it is false economy to over-run lamps, and also shows how important it is to have the voltage kept as constant as possible. In places where energy is cheap—say, 1d., 2d., or 3d. per unit—it may be worth while to over-run lamps slightly, because an extra expense in renewals can be more easily allowed. In places where the price is above 3d. per unit, it is generally best to run the lamps at the rated voltage and to throw them away after they have been in use some 400 or 500 hours, because, after this, running expenses will soon amount to the cost of a new lamp.

The Use of Large Lamp-bulbs. To reduce the amount of blackening on the inside of the lamp-bulbs, several manufacturers have recently adopted a type of lamp in which, although the filament is the same size as hitherto, the globe is two or three times the usual size. With this arrangement the molecules do not impinge with either as much force or frequency upon the hot filament, and any deposit of carbon which takes place now is spread over a larger area and is therefore less dense and less resisting to the transmission of the light.

The Candle-power of a Lamp. It is a difficult matter to define what is the candle-power of any source of illumination. A lamp emits light in all directions, and the difficulty of measurement arises from the fact that in some directions more light is being transmitted than in others. Fig. **184** shows diagrammatically the amounts of light emitted in the various directions. This lamp was evidently rated by the maximum amount of light it gave out in one direction, but another way is to estimate the total flux of light in every direction; and the average is spoken of as the "mean spherical candle-power." In street lighting, however, seeing that all light sent upwards is useless, it is more usual to speak of the "mean *hemi*spherical candle-power," meaning the mean candle-power emitted in all directions below the horizontal. The second curve given in **184** shows the effect of *frosting* the lamp-bulb. This diminishes by about 12 to 15 per cent. the total amount of light, but at the same time diffuses the light so that it is not very glaring in any one direction.



186. SHADE FOR DISTRIBUTING LIGHT



187. SHADE FOR CONCENTRATING LIGHT

Illumination for Various Purposes For the purpose of marshalling the distribution of the light, shades and reflectors are used. For this purpose white opaque materials (better not shiny) are preferable to mirror glass, because, although the loss in transmitting the light is 2 or 3 per cent. more, no deep shadows are thrown, and the lighting is therefore much softer. The shape of the shades and reflectors determines the quality of the illumination, and in **185** we have curves showing the light transmitted in various directions, using the shade shown in **186** and **187** with the same lamp. The first shade is evidently suitable for a distributive illumination, while the second is for concentrating the light, and should not be used for such as drawing-room lighting except if very intense lighting is required, when it can be used in clusters of four or five lamps each.

Continued

NINETEENTH CENTURY PROSE

3. Being the Concluding Part of Our Study in the Prose of this Period—from Carlyle to Stevenson—together with a Bibliographical Summary

Continued from page 2452

By J. A. HAMMERTON

Mrs. Carlyle. Almost as interesting as anything Carlyle wrote was the story of his own married life; in some way, indeed, that has been fruitful of more controversy than any of his boldest assertions in the domain of philosophy. JANE WELSH CARLYLE (b. 1801; d. 1866) was almost as notable a woman as her husband was a man, for her "Letters and Memorials" prove her to have been one of the most accomplished women of her time, a shrewd critic, fit to rank with the great letter-writers who have contributed no inconsiderable proportion of what we call our national literature. Mrs. Alexander Ireland wrote an excellent "Life" of Mrs. Carlyle.

Lord Macaulay. But Carlyle's greatest contemporary as an essayist and historian was THOMAS BABINGTON MACAULAY (b. 1800; d. 1859). Unlike Carlyle, Macaulay did not confine his labours to the desk. He was a public official and a member of Parliament as well as a man of letters. After a careful education, he became famous at the age of twenty-five as the writer of an essay on Milton in the "Edinburgh Review." In this review all his best known "Essays" appeared, if we except the biographies of Atterbury, Bunyan, Goldsmith, Johnson, and Pitt, which were contributed to the "Encyclopædia Britannica." The "Essays" are rich in applied knowledge, drawn from the exceptionally retentive memory of an omnivorous reader. The judgments they contain, where these are not affected by the author's Whig sympathies, are usually sound. For a parallel to their diversity of subject matter we must go to Landor's "Conversations." But Macaulay was essentially a popular writer, one whose purpose was to think for his readers and to leave nothing to chance. Whole generations may be said to have been nurtured on his writings. His influence will always be considerable both as a stylist and as a historian, though he will require to be edited with some care. The "Essays" on Warren Hastings and John Hampden, for example, are both based on inaccurate data. His great quality is clearness of diction, which he shares with Cobbett; but his use of a succession of short sentences, while flattering to the eye, is not invariably acceptable to the ear. He is apt to overburden his theme with detail. His use of antitheses is responsible for much deplorably ineffective imitation. He remains, withal, a brilliant writer; but, being brilliant, is hard. What he gains in glitter he misses in emotion; he does not delve very deeply into the heart of things; but without his aid many men and women of average insight and ability would never have been able to see so far or so well as they have seen. In this connection the educative value of Macaulay's writings cannot easily be exaggerated; it may be more easily satirised. In the realm of prose his relation to Carlyle is that of Tennyson to Browning in the realm of poetry. It is curious to notice that, in judging Scott, both Carlyle and Macaulay erred, if at all, on the side of severity; but it is useful to remember that neither of them had the "Journal" before him. Macaulay has been infinitely happier in his biographer than was Carlyle; the fine tribute of his nephew, Sir George Otto Trevelyan, to his memory reveals to us a family affection, for any sign of which we might search the "Essays" in vain.

Specimen of Macaulay's Style. We give as a sample of Macaulay's style a famous passage from the "Essay" on Von Ranke (1840):

"The Catholic Church is still sending forth to the farthest ends of the world missionaries as zealous as those who landed in Kent with Augustin, and still confronting hostile kings with the same spirit with which she confronted Attila. The number of her children is greater than in any former age. Her acquisitions in the New World have more than compensated for what she has lost in the Old. Her spiritual ascendancy extends over the vast countries which lie between the plains of the Missouri and Cape Horn, countries which, a century hence, may not improbably contain a population as large as that which now inhabits Europe. . . . She saw the commencement of all the governments and of all the ecclesiastical establishments that now exist in the world; and we feel no assurance that she is not destined to see the end of them all. She was great and respected before the Saxon had set foot on Britain, before the Frank had passed the Rhine, when Grecian eloquence still flourished in Antioch, when idols were still worshipped in the temple of Mecca. And she may still exist in undiminished vigour when some traveller from New Zealand shall, in the midst of a vast solitude, take his stand on a broken arch of London Bridge to sketch the ruins of St. Paul's."

Touching the study of Macaulay, it may be well to refer the student to our remarks on page 107, where, it will be remembered, we agreed upon a plan of study for different authors, making special mention of Macaulay.

Carlyle's Contemporaries. JOHN STERLING (b. 1806; d. 1844) was greater as a literary influence than as a writer. But he was a valued contributor to several reviews; his "Essays and Tales" were edited by his former tutor, J. C. Hare, and he was for a time proprietor and editor of the "Athenæum," and founder of that once famous literary circle, the Sterling Club. RICHARD CHENEVIX TRENCH

(b. 1807; d. 1886) was an indefatigable philologist whose "Study of Words" and other kindred books have proved worthy of bringing up to date. WILLIAM SPALDING (b. 1809; d. 1859) was a contributor of Shakespearean articles to the "Edinburgh," and wrote a small "History of English Literature." EDWARD FITZGERALD, a member of the Sterling circle, is, as a prose writer, best represented by his "Euphranor: A Dialogue on Youth," and his wonderful letters. A now all but forgotten worthy, ROBERT ARIS WILLMOTT (b. 1809; d. 1863) did not a little by his biography of Jeremy Taylor to promote a study of that writer, and by a charming little work on the "Pleasures, Objects, and Advantages of Literature" to win a well-merited reputation for quiet and simple scholarship. JOHN BROWN (b. 1810; d. 1882), the author of some delightful essays entitled "Horæ Subsecivæ" (Leisure Hours), will always have a place by the side of Charles Lamb. He is easily among the masters of English prose, and his little sheaf of writings is one of the most precious in our harvest of Literature. JOHN FORSTER (b. 1812; d. 1876) wrote many admirable essays in history and biography. His "Life of Dickens" remains the most popular of his works. Sir ARTHUR HELPS (b. 1813; d. 1875) wrote a series of essays and dialogues entitled "Friends in Council," which have long lost favour. He edited the speeches and addresses of the Prince Consort and Queen Victoria's "Leaves from a Journal of Our Life in the Highlands." To RICHARD WILLIAM CHURCH (b. 1815; d. 1890) we owe a standard criticism of Dante and able studies of Spencer and Bacon in the "English Men of Letters." MARK PATTISON (b. 1813; d. 1884), another contributor (of the volume on Milton) to this series, wrote a "Life of Isaac Casaubon," a well-known classical scholar who lived in the sixteenth century. Compared with his scholarship, Pattison's output was singularly limited; but his life-story is a fascinating if sad one. He is mercilessly caricatured as Mr. Casaubon in "George Eliot's" "Middlemarch." Sir CHARLES GAVAN DUFFY (b. 1816; d. 1903) wrote a charming work on "The Ballad Poetry of Ireland." GEORGE HENRY LEWES (b. 1817; d. 1878) founded and edited the "Fortnightly Review," and did much to popularise philosophy and science.

Froude and Others. The name of JAMES ANTHONY FROUDE (b. 1818; d. 1894) is the centre of a perfect whirlwind of controversy. As a partisan he excelled Macaulay. His contentious character colours all he wrote, but his "Nemesis of Faith," "Oceana," "Short Studies on Great Subjects," and his "Lectures" possess a positive if all but indefinable fascination for most readers. He wrote with a sincerity that was almost Carlylean, and his thought frequently soars to heights of undeniable eloquence. GEORGE BRIMLEY (b. 1819; d. 1857) was a critic whose anonymous contributions to "Fraser's" and the "Spectator" thoroughly merited their republication in collected form. His studies of Tennyson, Wordsworth, Patmore, Carlyle, Thackeray, Lytton, Dickens, Kingsley, Wilson, and Comte justify his place in literary history by the side of such writers as RICHARD HOLT HUTTON (b. 1826; d. 1897), WALTER BAGEHOT (b. 1826; d. 1877), JAMES HANNAY (b. 1827; d. 1873), HENRY HILL LANCASTER (b. 1829; d. 1875), HENRY MORLEY (b. 1823; d. 1900), Sir JAMES FITZJAMES STEPHEN (b. 1829; d. 1894), LESLIE STEPHEN (b. 1832; d. 1904), WILLIAM MINTO (b. 1845; d. 1893), JAMES THOMSON, "B.V." (b. 1834; d. 1882), WILLIAM ERNEST HENLEY (b. 1849; d. 1903), and others.

The Influence of Ruskin. JOHN RUSKIN (b. 1819; d. 1900) proved a great social force as well as a great critic. Perhaps his paramount service in criticism was his defence of Turner. He imparted an incalculable impetus to the raising of the standard of labour; whatever nature of labour it may be, it can hardly be regarded without some respect by anyone who has come under the influence of Ruskin's teaching. Like Carlyle, and, in a lesser degree, like Froude, Ruskin gloried in the power of imparting and inspiring enthusiasm. He sought after the truth with all the ardour of Carlyle, and the student of his works will witness with mingled feelings how, time after time, he was compelled by his own discoveries to relinquish positions he once thought to be unassailable. He was the embodiment of the spirit of reverence and a high priest of the temple of beauty. He has opened our eyes to the infinite variety and charm of external nature, and even the clouds have a different meaning to us since Ruskin wrote about them. His style glows with rich colour and is full of musical sweetness. It is impregnated with the influence of Bible study, an influence which, however, can be realised only by those whose knowledge of the Bible corresponds in some measure to his own.

What Arnold Taught Us. MATTHEW ARNOLD (b. 1822; d. 1888), whose work as a poet has been discussed in these pages, combined social with literary criticism. He foretold the fall of the aristocracy and distrusted the middle-classes, but much that has been written and said concerning his "contempt for unintellectual people" is unjustified, and caused him no small amount of disquiet, as his "Letters"—especially the epistle written to his mother in 1868—testify. As a writer, he had much in common with Sainte-Beuve, perhaps the greatest literary critic of the nineteenth century, his standpoint in regard to art and letters being in many respects more French than English. First and foremost he was a scholar, and valued scholarship highly. His "Essays in Criticism," "Culture and Anarchy," "Literature and Dogma," and an earlier work, "On Translating Homer," are his most widely-read books; but there is no complete edition of his prose writings, and no definite biography has been written of him. Mr. G. W. E. Russell, in his very able but unsatisfying monograph, sums up the indebtedness of his friends and followers to Matthew Arnold in these words: "We who were happy enough to fall under his personal influence can never overstate what we owe to his genius

and his sympathy. He showed us the highest ideal of character and conduct. He taught us the science of good citizenship. He so interpreted Nature that we knew her as we had never known her before. He was our fascinating and unfailing guide in the tangled paradise of literature. And while for all this we bless his memory, we claim for him the praise of having enlarged the boundaries of the Christian Kingdom by making the lives of men sweeter, brighter, and more humane."

Walter Pater and Others. Eminent among the other critics who lent distinction to English letters in the latter part of the nineteenth century was WALTER HORATIO PATER (b. 1839 ; d. 1894), whose exclusiveness was akin to that which so long kept Matthew Arnold aloof from the average reader, and whose "Sketches in the History of the Renaissance," "Imaginary Portraits," and "Appreciations" are marked by an exotic beauty of style, refinement of taste, breadth of culture, and keenness of insight. Into the point of view of Walter Pater it is not here necessary to enter, but this must come into consideration where the permanent value of his work is considered. A similar remark is called for in regard to the writings of another and a less "precious" hedonist, JOHN ADDINGTON SYMONDS (b. 1840 ; d. 1893), who also helped to bring the bright side of the Renaissance, as well as that of Elizabethan England, before English readers. PHILIP GILBERT HAMERTON (b. 1834 ; d. 1894) wrote a series of letters on "The Intellectual Life" which literary aspirants should not neglect. Young people especially should read "The Ideal Life," by HENRY DRUMMOND (b. 1851 ; d. 1897), author of "Natural Law in the Spiritual World," whose "Life," by George Adam Smith, is one of the finest of modern biographies.

Another critic of varied talent and remarkable industry was WILLIAM SHARP (b. 1856 ; d. 1906), and there is literary charm in the essays of RICHARD JEFFERIES (b. 1848 ; d. 1887), while a fine quality marks the essays of ALFRED AINGER (b. 1837 ; d. 1904). The life work of RICHARD GARNETT (b. 1835 ; d. 1906), biographer and literary historian, should be studied as exemplifying the possibilities of self-help and the value of adopting a wide, as against a narrow and "specialist," interest in literature—a point we have already found occasion to emphasise.

The Essays of "R. L. S." ROBERT LOUIS BALFOUR STEVENSON (b. 1850 ; d. 1894) has been described as "the happiest master of vagabond discourse in the whole of the nineteenth century." He travelled directly for his health's sake ; the indirect benefit of his travels to English literature it is difficult to over-estimate. He began as an essayist, and his chief prose works, apart from fiction, are "An Inland Voyage," "Travels with a Donkey in the Cevennes," "Virginibus Puerisque," "Familiar Studies of Men and Books," "Memories and Portraits," and "Across the Plains." He won fame first as a writer of romance, and then, turning to the hitherto almost neglected prose essays, the public found in them the most intimate and delightful self-revelations of a winning personality. Stevenson's style is the outcome of infinite labour ; it is not a style that could be copied with profit, but the young writer with aspirations should read, mark, learn, and inwardly digest all the books we have just named. "In an age of journalism," says Professor Raleigh, "of barren repetition and fruitless expatiation, it is high praise to give even of a great prose writer to say of him that he never proses. This praise is due to Stevenson ; his chisel, which rang in the workshop of many masters, was always wielded under the direction of a marvellously quick eye, by a hand that gathered strength and confidence every year. He has left no slovenly work, none that has not an inimitable distinction, and the charm of expression that belongs only to a rare spirit. If the question be raised of his eventual place in the great hierarchy of English writers, it is enough to say that the tribunal that shall try his claims is not yet in session ; when the time comes he will be summoned to the bar, not with the array of contemporaries whose names a foolish public linked to his, but with the chief prose writers of the century, few of whom can face the trial with less to extenuate and less to conceal."

We have now noted most of the important prose-writers of the nineteenth century, excluding those who are still alive ; but there remain a good many names which call at least for mention, and without endeavouring to compile a complete list of these, we shall indicate as many as possible in the bibliographical summary with which we bring this section of our study to a close. It will be worth our while to reserve for separate consideration those writers who, though essentially of the nineteenth century, are still living. Therefore, in our next study we shall pass in review the representative writers of prose, other than that of fiction, from Masson to Chesterton.

Biography and History. The works of some of the chief biographers and historians of the nineteenth century have been referred to already. In the field of biography the following books are generally admitted to be of permanent value : Southey's "Nelson" ; Lockhart's "Scott" ; Lewes's "Goethe" ; Carlyle's "Sterling" ; Froude's "Carlyle" ; Stanley's "Arnold" ; Forster's "Dickens" ; Milman's "Gibbon" ; Mrs. Gaskell's "Charlotte Brontë"; Masson's "Milton" ; Spedding's "Bacon" ; Sidney Lee's "Shakespeare" ; Gifford's "Ben Jonson" ; Cross's "George Eliot" ; Dowden's "Shelley" ; Martin's "Prince Consort" ; John Morley's "Voltaire," "Rousseau," and "Gladstone" ; and Lord Tennyson's "Life" of his father.

History bulks largely in the period under review. The chief works on English history are Hallam's "Constitutional History of England" ; Lingard's "History of England to 1688" ; Macaulay's "History of England, from the Accession of James II." ; Carlyle's "Cromwell's Letters and Speeches" ; Froude's "From the Fall of Wolsey to the Defeat of the

Armada"; Green's "Short History" (the best of its kind); Gardiner's "History of England, 1603–1642," "History of the Great Civil War," "History of the Commonwealth and Protectorate," and "Oliver Cromwell"; Freeman's "History of the Norman Conquest," "Growth of the English Constitution," and "The Reign of William Rufus"; Stubbs's "Constitutional History of England"; Sharon Turner's "History of the Anglo-Saxons"; Seeley's "The Expansion of England"; Buckle's unfinished "History of Civilisation"; Lecky's "History of England in the Eighteenth Century," and other works on European history; Seebohm's "The Oxford Reformers of 1498," "Era of the Protestant Revolution," "The English Village Community," and "Tribal System in Wales"; Creighton's "Simon de Montfort," "History of the Papacy during the Reformation Period," "Queen Elizabeth," and a charming little manual on "The Age of Elizabeth"; Palgrave's "Rise and Progress of the English Commonwealth"; Firth's several books on the Commonwealth; Brewer's "Henry VIII."; and May's "Constitutional History of England, 1760-1863."

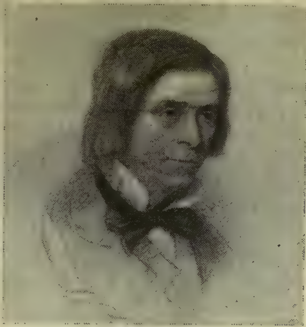
In addition must be noted Mill's "History of British India"; Maine's "Village Communities," and "Popular Government"; Tytler's "History of Scotland"; Burton's "History of Scotland"; Coxe's "House of Austria"; Grant Duff's "History of the Mahrattas"; Elphinstone's "History of India," and "Rise of the British Power in the East"; Kaye's "Histories of the Afghan and Sepoy Wars"; Kinglake's "Crimea"; Mitford's, Thirlwall's, Grote's, and Finlay's histories of Greece; Thomas Arnold's "History of Rome"; Alison's "History of Europe"; Merivale's "History of the Romans under the Empire"; Milman's "History of Latin Christianity"; William Napier's "History of the Peninsular War"; and Agnes Strickland's "Lives" of the Queens of England and Scotland.

Theology and Philosophy. Students of philosophy and theology are recommended to refer to the following names in any good biographical dictionary: Jeremy Bentham, Sir William Hamilton, Henry Mansel, Richard Whately, William Whewell, David Ricardo, J. R. McCulloch, John Stuart Mill, Richard Owen, Charles Darwin, Herbert Spencer, Thomas Henry Huxley, W. A. Butler, Thomas Hill Green, G. H. Lewes, Sir James Mackintosh, Thomas Malthus, John Keble, Edward Bouverie Pusey, Richard William Church, John Henry Newman (whose style is especially important to students of the language), W. E. Gladstone, Arthur Penrhyn Stanley, Thomas Chalmers, John William Burgon, Richard Hurrell Froude, Edward Irving, Henry Parry Liddon, Joseph Lightfoot, Frederick Denison Maurice, James Mozley, James Craigie Robertson, Frederick William Robertson, Richard Chenevix Trench, John Tulloch, Christopher Wordsworth, William Wilberforce, Charles Haddon Spurgeon, R. W. Dale, and James Martineau.

Travel and Science. The records of travel and exploration are brightened by such names as those of Austen Layard, Samuel Baker, David Livingstone, John Pinkerton, Charles Waterton, George Borrow, Richard Burton, and Edward Lane. Some mention must also be made of the scientific studies of Max Müller, Charles Lyell, John Tyndall, and Humphry Davy. The educational writings of four women—Harriet Martineau, Hannah More, A. L. Barbauld, and Charlotte Yonge—may be cited as witnesses to the rise and progress of "woman's emancipation," which was so striking a feature of the nineteenth century.

Books to Study. There is no satisfactory history of our nineteenth century prose. The nearest approach to one is found in Professor Saintsbury's work (Macmillan, 7s. 6d.). The final volume of Sir Henry Craik's "Selections" (Macmillan, 8s. 6d.) is an invaluable guide. The "Maclise Portrait Gallery," by William Bates (Chatto & Windus, 3s. 6d.), is a mine of useful information concerning the men and women of letters who lived during the earlier half of the century. Messrs. Chatto and Windus also issue M. Taine's "History of English Literature," in four volumes, at 2s. net a volume. Professor Herford has edited for Messrs. Blackie, a series of volumes called "The Warwick Library." Of these, "English Historians," by Professor Grant; "English Essays," by J. H. Lobban; and "English Literary Criticism," by Professor Vaughan (2s. 6d. per vol.), contain much that is commendable. The following volumes in the "English Men of Letters" series are also recommended: "Carlyle," by Professor Nichol; "De Quincey," by Professor Masson; "Charles Lamb," by Canon Ainger; "Landor," by Sidney Colvin; "Matthew Arnold," by H. W. Paul; "Macaulay," by J. L. Morison; "Hazlitt," by Augustine Birrell; "Ruskin," by Frederic Harrison; "Edward FitzGerald" and "Walter Pater," by A. C. Benson. Matthew Arnold is also the theme of useful monographs by G. W. E. Russell (Hodder & Stoughton, 3s. 6d.); W. Harbutt Dawson (Putnam's, 6s.); and Professor Saintsbury (Blackwood, 2s. 6d.). For Messrs. Blackwood's "Modern English Writers," Mr. L. Cope Cornford has written a Life of R. L. Stevenson; Lives of Ruskin and Huxley have been written by Mrs. Alice Meynell and Mr. Edward Clodd respectively. Dr. Barry's Life of "Newman" (Hodder & Stoughton, 3s, 6d.) is excellent. Messrs. Ward, Lock have published shilling editions of Cobbett's two grammars, and this virile writer's "Advice to Young Men" has been republished by Messrs. Routledge, also at 1s. Inexpensive reissues of Carlyle's works are published by Messrs. Chapman & Hall; while Messrs. Longmans have rendered similar service by the publication of popular editions of the works of Macaulay (together with the "Life," by Sir G. O. Trevelyan) and Froude. Mr. George Allen is producing Ruskin in inexpensive form, and much of R. L. Stevenson has been added to Messrs. Chatto & Windus's "St. Martin's Library."

Continued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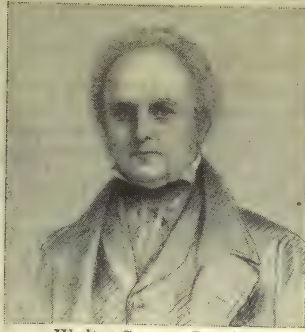
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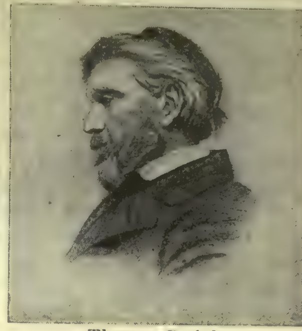
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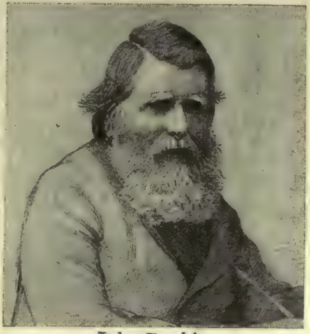
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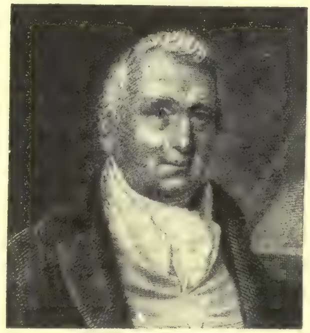
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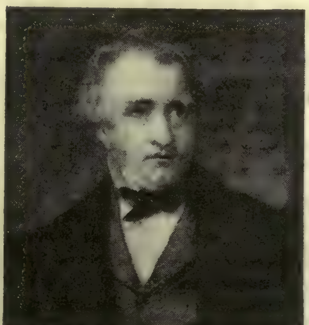
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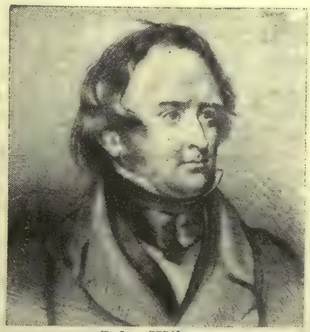
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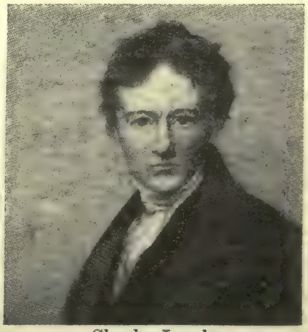

Charles Lamb

FAMOUS PROSE-WRITERS OF THE NINETEENTH CENTURY

The portrait of Carlyle is from a photograph by Elliott & Fry, and that of R. L. Stevenson from a drawing by F. R. Spence

continued from page 2371

DISEASES OF LIVESTOCK.

Symptoms and Method of Treatment of the Chief Diseases of Horses, Cattle, Sheep, and Pigs. A Medicine Chest. Insect Parasites

By Professor JAMES LONG

DISEASES OF HORSES

The temperature of the body frequently proves a guide in sickness. The stockowner should, therefore, obtain a clinical thermometer and learn how to use it. The temperature of the horse is from 100° to 101° F., a rise to 103° denoting a feverish condition, and from 105° to 106° a high fever. The bulb of the thermometer is very carefully introduced into the rectum, and there maintained from three to four minutes in order to obtain an accurate reading. The pulse, which is usually taken under the side of the jaw, where the artery will be felt, beats from 36 to 45 times per minute in health, but the horse must be perfectly quiet. A beat of over 60 denotes fever. The pulse is rapid and small in such complaints as inflammation of the bowels, and weak in influenza; but inasmuch as its volume, rhythm, and character are all important, professional help should be obtained in cases of grave suspicion. Under normal conditions, the horse when standing quiet breathes 12 times in a minute.

The horseowner should carefully remember the fact that there are certain contagious diseases, anthrax, glanders, farcy, and rabies, which are scheduled, and which must be notified to the police or such authorities appointed for the purpose, even where the complaint is only suspected. All being dangerous to man, this notification, accompanied by absolute isolation of the animal, is all the more important.

Colic and Gripes. These much too common complaints are frequently caused by improper feeding or sudden change of food; by impaction; by the taking of too much green food, or by drinking a quantity of cold water when overheated. The animal perspires freely, and rolls on the ground in pain, which may be spasmodic. An injection of warm water often affords relief, or a dose of from 5 to 10 drams of aloes where spasm exists. If there is flatulence, linseed oil or ammonia is useful, together with massage. It is important to ascertain that the case is not one of inflammation, in which the pain is continuous. Gripes are often removed by a draught composed of chlorodyne, hyposulphite of soda, and bicarbonate of potash, the dose being arranged by an experienced chemist, who should be acquainted with the age and condition of the animal.

Enteritis, or Inflammation of the Bowels. This very dangerous disease, from which animals seldom recover, somewhat resembles colic, but the temperature is high, the body cold, the pulse fine and hard, and the belly tender. Hot fomentations are useful, but there is practically no remedy, although in all cases the best skill should be employed.

Gastritis, or Inflammation of the Stomach. This disease closely resembles that just referred to, and is almost equally dangerous. Amateur physicing should be avoided.

Diarrhœa. This is more common in young than in older animals, and may be attributed to chill, sudden change of food, improper food, acidity, or worms. The cause should first be ascertained, and the remedy applied in accordance with it. Foals with their dams may receive a dose of castor oil and laudanum, while acidity in the milk of the dam may be neutralised by the aid of carbonate of soda. Mixtures of opium powder, catechu and chalk, or of catechu and chlorodyne, may be administered, the dose being arranged by a druggist in accordance with the age and condition of the animal.

Glanders and Farcy. This contagious disease—for glanders and farcy are practically one—must, even on suspicion, be notified to the police, the horse being isolated. It is contagious to man, and is the result of the woık of an organism known as *Bacillus malleus.* There is a sticky discharge from the nostrils, usually, however, from one nostril. When the disease is recognised or proved by the injection of the material used for the purpose, and known as mallein, the horse is destroyed. In bad cases there is high fever. Glanders and farcy take different forms, the latter affecting the limbs and skin, one disease running into the other.

Catarrh. This somewhat common complaint is not of a serious character, although it should be promptly handled. It is owing to the sudden changes of the weather, coupled with bad or irregular feeding, and indigestion, and may cause loss of condition and weight. A horse with catarrh should be rested in an airy yet warm and dry stable, and fed on simple food, such as mashes of bran, crushed oats, linseed tea, and cooked roots. Little drink should be given. Terebine and spirits of camphor are useful.

Pink Eye, or Distemper. This is an infectious disease attended with great loss of strength and condition, and accompanied with a thin discharge from the nostrils, cough, and fever. The temperature may rise to 104° or 105° F. A redness of the membrane of the eyelid is usual. There is thirst, constipation, and scanty urine, with a weak pulse. The animal should be stabled, as in the case of catarrh, isolated, well nursed and fed, receiving gruel, eggs and milk, if there is great loss of strength, mashes, linseed tea, and steamed crushed oats. A little spirit may be good to sustain the strength. The temperature should be taken, and if the attack is severe, a veterinarian should be employed, since there are occasionally serious complications, involving pleurisy, bronchitis, or the liver.

Pleurisy. This is practically inflammation of the membrane covering the lungs. There is cough, a thin and wiry pulse, with high temperature. The animal should be clothed and kept warm, and mustard applied over the affected part.

Pneumonia. Although this disease is probably owing to the presence and action of a specific germ, it may be indirectly owing to exposure, overheating, and chill, or even a damp stall. The pulse is tiny and very rapid, and the breathing quick. A case should be treated with great promptitude by a professional man.

Strangles. This chiefly attacks young horses. Its most important symptom is an abscess under the jaw, which is usually blistered or fomented until it breaks, or is ready for the lance. In either case it should be kept clean with antiseptic.

Fistula. This disease appears on the withers, and should be attacked immediately it is noticed, inasmuch as if neglected the bony structure beneath may be implicated and recovery become impossible. The aid of a veterinary surgeon is essential, that the part may be opened and cleansed. The affected horse should not be worked, but allowed freedom for sufficient exercise and pure air. The feeding should be sound but not high, the efforts of the owner being directed to maintenance of good bodily condition, that the animal may throw off the abnormal formation, and build up new tissue.

Worms. The digestive organs of the horse are attacked from time to time by worms [7, page 2627] of parasitic character of several varieties. Some are known to be consumed when grazing, especially on wet land. This is the case with the red parasite known as *Strongylus tetracanthus,* a bloodsucker, the presence of which is followed by diarrhœa, wasting, and often by death. It may be noticed in the manure of the horse, and wherever observed steps should immediately be taken to remove the animal into a dry, light, and well ventilated box which is thoroughly clean, and to feed and nurse him in the best manner possible, milk and eggs, linseed tea, gruel, and mashes being employed. The treatment of horses with worms, however, depends upon the variety of the parasite. Turpentine and oil or santonin are usually employed. Here, again, advice will be found the cheapest help in the end.

Cracked Heel. This is usually accompanied by lameness, and may be caused by a wet stall, or constantly wet feet. Washing the feet should be avoided, the dirt being allowed to dry and then removed with a brush. White vitriol ointment may be employed as for thrush and sore shoulders.

Curb. This is a swelling which appears a little below the hock, and is better recognised in profile. The part may be blistered or fired.

Founder, or Inflammation of the Feet. Founder frequently follows bad feeding, cold or wet. The feet become heated, and the horse is in pain, and prefers to rest. He loses condition, and exhibits great thirst, the pulse being meanwhile strong. The shoes should be removed, and cold bran poultices applied to the feet. The bed of the stall should be covered thickly with short straw or peat moss, and very little exercise given, and that on soft soil. A few draughts or drenches should be obtained to help the animal through, a little green food being given when recovery begins.

Grease. This term is applied to a greasy condition of the skin of one or more limbs, and is sometimes accompanied by a discharge. The affected parts may be powdered with boracic acid and alum, and kept clean and carefully bandaged. The animal should be fed well, green food being supplied ; a ball from the veterinarian will help to bring back condition.

Capped Hocks. This is practically a swelling of a tendon, which is followed by a condition resembling a cap over the point of the hock. It may result from a bruise. The seat of the disease may be in or beneath the tendon. The horse should rest, and the affected part be regularly dressed with a lotion obtained from a druggist skilled in these matters or from a veterinarian. There are two or three firms who provide collections of lotions and medicines for simple diseases at reasonable prices.

Broken Knees. Broken knee is usually the result of a fall. A mere bruise or graze, if kept clean, rapidly heals, but where the joint is opened there is a discharge of fluid (synovial), usually known as joint oil. As this is serious, attention must be given at once, and even then prolonged rest and nursing will be necessary for recovery. Care must be taken to remove any grit or dirt, and the wound should be dressed with a special lotion obtained for the purpose, and then bandaged. Both cleaning and dressing should be frequent, the sponge being soaked in water which has been purified with an antiseptic. An oil of cloves dressing on cottonwool will be found useful.

Mange. This is a contagious, inflammatory condition of the skin caused by the activity of a parasite. The horse rubs himself, and the hair falls off, while condition is lost. He should be isolated in a clean stable, and dressed with sulphur ointment. Neither stable nor brushes employed for the patient should be used until thoroughly disinfected.

Mud Fever. This is really an irritation caused by the presence of dirt allowed to accumulate on the skin, and bad stable management ; an eruption also appears, usually on the legs, with loss of condition. The horse may be fed on bran mashes, crushed scalded oats with a little green food and an odd mangel or carrot or two, with a little first-class hay ; an ounce of linseed oil may be given each night and a few powders obtained from a veterinarian.

Navicular. This is a disease of the navicular bone and its surroundings, usually in the fore feet. The horse goes shaky or limp, and although he may do a little work, he becomes practically unsalable. Help can be given, but no cure effected, by a veterinary operation, after which a short-toed shoe with a leather sole may be provided for the affected foot.

Quittor. This involves a swollen and heated coronet with running sores, often

caused by the presence of matter arising from a wound in the sole; the matter is discharged from the suppurating sores instead of below. Whether the wound is caused by a nail or otherwise, the place should be cleaned with an antiseptic dressing and encouraged to discharge below by poulticing. In the presence of quittor, however, the sores must be opened, cleaned, and induced to heal by the promotion of a healthy condition of the affected parts. Rest should be given, and the work performed by a veterinarian.

Ringbone. This disease, usually in the hind legs, may be seen when really large, or detected by the fingers of an expert on or near the pastern joint. It may be caused by a blow followed by inflammation and lameness. Rest and firing by a veterinarian may have good results.

Ringworm. Ringworm is caused by a parasite, the irritation being followed by loss of hair. The patches should be kept clean and dressed with tincture of iodine or an ointment.

Sandcrack. In this case the horny structure of the hoof cracks, and may cause lameness; the extension of the crack must be prevented, and a healthy condition promoted by light exercise, cleanliness of the part, and the drawing of the divided portions together. The horse must rest if in pain.

Sidebone. This is a hardening of the flexible cartilage behind the cannon bone, usually on the fore legs. It diminishes the value of a horse, although he may do good work for years. Rest may be necessary, and sometimes firing, but turning out in suitable weather for some weeks may have excellent results.

Spavin. Serious as this complaint is in the horse used for fast work, farm and cart horses suffering from it are commonly employed and often work as well as when sound. Spavin is the result of inflammation which attacks the bone of the hock, and which is followed by enlargement and lameness. If the enlargement is not noticeable, it may yet be discovered by the touch of a skilled hand. The horse should be rested and professionally treated, and the wisest plan is to turn the animal out to grass if weather permits.

Splint. Splint attacks horses ridden and driven rather than cart or farm horses. It is really a bony deposit on the cannon bone, usually of one of the fore legs, which causes lameness. Both heat and pain are present. The former may be reduced by cold sponging, and the latter by resting. A blister may be found useful, but one should be guided by a professional man.

Thoroughpin. This trouble is a fluid distension or swelling, which is movable, and which appears at the back of a hock. It is sometimes painted with iodine, and sometimes punctured, but needs professional treatment.

DISEASES OF CATTLE

Anthrax, or Black Quarter. This very dangerous disease, known under many names, usually attacks young stock, and is due to the presence of a bacillus, and is extremely fatal. The attack is sudden, the limbs swell, stiffness follows, with loss of appetite, extreme weakness, and a weak and rapid pulse. In severe cases death may follow in a few hours. A veterinarian should be called in at once, and no time lost in efforts to sustain strength and to ameliorate the symptoms. The best plan, however, is to act on the principle of prevention, keeping the stock in good condition, never turning them out into fields where anthrax has occurred, and, on farms where there has been loss from the disease, to insert a seton in the dewlap. In case of attack the animal should be isolated, its bed and manure burnt, and its stall purified, while after death the body should be buried in lime, or, still better, burnt, if this is possible.

Catarrh. This is recognised by a running at the eyes and nose, which may follow chill and exposure. It should be checked before going too far, as it may be succeeded by complications of a most serious character. Protection and good feeding are essential. The animal may receive a dose of Epsom salts, in accordance with its age, well fortified with ginger. In a severe case the feeding should consist of good gruel, warm bran mashes, scalded oats, and good hay-chaff, and, if obtainable, some green food—grass, clover or vetches—given in small quantities at a time. The system needs stimulating and well feeding, while a dry stall, ventilation, and a little exercise should be provided.

Husk, or Hoose. This attacks calves and quite young stock turned out to grass, and more commonly in their first year. It is caused by the presence of a worm, *Strongylus micrurus*, in the trachea, or windpipe. There is cough, followed by weakness, and, in bad cases, by death. Wet land should be avoided at all times. When an outbreak occurs, the stock should be changed to drier soil; indeed, all young animals should be fed on dry pastures, and fed well. It is the ill-fed youngster which usually falls a victim to husk, and here the master's eye exercised daily over his herd is so valuable. A daily dose of turpentine may be administered, or, if the case is obstinate, the veterinarian may be instructed to attempt to destroy the organisms, which sometimes respond to skilled action or to inhalation.

Consumption, or Tuberculosis. This is, perhaps, the most destructive among all diseases of cattle. It has been stated on authority that 40 per cent. of the cattle in the country are affected. If it is suspected, the tuberculin test may be applied by a veterinarian, the rise in temperature, if definite, deciding the question.

No tuberculous beast should be sold or allowed to remain near healthy stock, infection being extremely dangerous. Milk should not be sold from a tuberculous beast, nor calves and swine fed on the milk, unless it has been boiled.

Red Water. This serious complaint is usually recognised by the dark or red colour of the urine and diarrhœa, which is usually followed by constipation. Unless in very severe cases, a pound of Epsom salts may be given as a purge, followed by daily doses of oil and turpentine. The disease is accompanied by great weakness, so that good nursing and rich feeding are essential. The animal should receive milk, gruel, linseed

tea, and, if necessary, spirits, but in all cases it is a wise policy to obtain the assistance of a veterinary surgeon. The cause of the disease is not fully known, but it is more common on moorland soils than elsewhere.

Influenza. The symptoms resemble intensified catarrh, with fever and prostration. The disease is contagious. If there is constipation, as is most likely, a pint of linseed oil may be given, a little more, if necessary, followed by enemas if the trouble is continued. The animal should be isolated, and advice obtained in all cases. The feeding may consist of bran mashes, gruel, and a little green food from time to time. Water in which linseed has been boiled may be given as a drink. The body should be kept warm in a well-ventilated stall, and good nursing and rest provided.

Pneumonia. This is recognised by a hard cough, cold ears and feet, hot, rapid breathing, chill, weakness, and refusal to eat. The exciting cause is usually exposure and chill. The patient should be well wrapped up in a dry air-box, and fed on milk, mashes, linseed tea, and a little green food. It is always well to obtain an accurate diagnosis, advice, and medicine from an expert.

Pleuro-pneumonia. This is a contagious disease, which must be reported when recognised. It is frequently fatal, running its course with rapidity. There is thirst, cough, refusal to feed, a hot, dry muzzle, foul-smelling breath, and foul, dry manure, with, in bad cases, wasting, and running mucus from the mouth. The disease is imported. In all suspected cases there should be isolation, disinfection, professional advice, and slaughter on recognition.

Foot and Mouth Disease. This is a contagious and disgusting disease, which must be notified to the police. There is shivering, salivation, weakness, rapid pulse, with inflammation, eruption on the mouth, tongue, oftentimes on the feet, and sometimes on the udder. An aperient should be given, to consist of a pint of linseed oil or ¾ lb. of Epsom salts, the affected places being dressed with a sulphate of zinc lotion. Salicylic acid in ¼-oz. doses, or sulphite of sodium in 3-drachm doses in water may be given twice daily. If the feet are attacked, boracic acid may be dusted over them. An attack may involve a number of animals, which will need constant attention to prevent too great loss of condition, and the spreading of the complaint. There should be isolation and complete disinfection. Patients may be supplied with linseed water as drink, linseed tea, milk, mashes, gruel, cut grass, and any food likely to tempt the failing appetite. The milk of affected cows should not be used for healthy stock.

Abortion, Slinking, or Casting Calf. Abortion is caused by accident, exposure, or contagion, the calves being usually cast in the fifth month. In any case the cows should be isolated, thoroughly disinfected, the fœtus, cleansing, and all matter connected with both buried with lime, or burnt. A cow which has once been affected should not be used for breeding again until nine months have elapsed, or she may be fattened and sold. There is always danger in buying in-calf cows in fairs and markets; hence the importance of some days of isolation before mixing with the herd. After a case of abortion every animal in the herd should be disinfected by sponging the vent with a solution composed of 20 pints of distilled water, 3 oz. of glycerine and alcohol (specific gravity 36), and 2½ drachms of bichloride of mercury (poison). One case of contagious abortion may be followed by others unless great precautions are taken.

Milk Fever, or "Drop." This is a very dangerous complaint, often attacking cows which are in high condition and of particular strains. The animal falls soon after calving, displaying weakness, a dry, hot muzzle, and perhaps relapses into a state of coma. The actual cause is unknown; prevention is the wisest course. Fleshy or suspected cows should be turned out on scanty pastures after drying off, or, if stall-fed, kept on light rations, of which bran mashes form part, linseed water being occasionally used to keep the bowels in order. A pint of salts given twice with intervals shortly before calving is a practice many follow with success. Where the appearance of the cow raises suspicion that she may fall, 10 to 12 drops of tincture of aconite may be given, and continued every six hours or so, if there is no change. Where a case occurs, the animal should be well wrapped up to maintain warmth, the bowels being kept open with linseed oil, salts, or a gruel enema.

Garget. This is a troublesome complaint attended with great risk and loss in value in the cow. The udder is attacked by inflammation, and its internal structure involved, so that the power of yielding milk may be lost. It is usually owing to chill, injury, or bad management. The udder becomes hard, but may be massaged, and the calf used to empty it from time to time. When garget appears, the udder may be poulticed with linseed meal, and medicine obtained from the veterinarian. If an ulcer forms, it should be kept clean with an antiseptic, such as carbolic acid, 1 part to 25 parts of water. Simple *hard udder*, which often occurs after calving, may be reduced by giving ¾ lb. of salts and an ounce of ground ginger in gruel, followed by frequent rubbing, and by allowing the calf to suck oftener.

Hoven. This usually occurs from overeating young, fresh green food in spring, especially where cows break bounds and enter a field of vetches, clover, or some other green crop, when the dew is upon it. The animal is blown with gas, parts of abdomen when tapped resounding like a drum. In bad cases the distension presses on the heart, the circulation is impeded, and death may occur by suffocation. The commonest simple remedy is ¼ lb. of hyposulphate of soda, given in a pint of water, this being repeated in a short time if necessary. If it is perceived that a cow is in danger, the paunch should be pierced with a trocar and canula, which should be kept on every farm, or, failing this, with a penknife, behind the short ribs on the left side. The trocar is removed, and the canula, through which the gas quickly passes, remains in the wound, which should be kept

clean, and which with care will quickly heal. After relief the animal must be nursed, first getting an aperient—1 lb. of Epsom salts, with some ground ginger, or a pint of linseed oil—to clear the bowels. Food should be given in small quantities until danger has passed, to include gruel, bran mashes, and linseed water.

Impaction. This is also the result of gorging abundant dry or green food. There is less gas in this case, but action should be taken with linseed oil to purge the system. In bad cases advice must be obtained.

Colic. This trouble is often caused by overfeeding or bad feeding, followed by pain in the bowels, the generation of gas, and swelling. The first remedy is 1 lb. of salts, with 1½ oz. of ginger, ½ oz. of aloes being sometimes added. If necessary, a stimulant must be supplied, and in all cases help obtained. There may be gentle massage with dry mustard. The feeding to follow relief should be chiefly composed of bran mashes. Colic may be caused by chill, or drinking too much very cold water. Where there is little gas evolved, but more pain, a pint of linseed oil may be given, followed by a soothing drink, which should include opium, obtained from a veterinary surgeon.

Inflammation of the Bowels. This disease is accompanied by pain, perspiration, and rapid pulse. It is caused by exposure and chill, and the consumption of quantities of cold water when the animal is heated. Ether and opium are usually given, but, again, the master should leave himself in the hands of a skilled adviser.

Diarrhœa. If the fæces are largely mixed with mucus, great weakness soon follows an attack, but simple looseness, although it should not be ignored, may mean nothing. Bad cases occur from sudden changes of food or of pasture, from the consumption of bad food or water, and from chill. A pint of linseed oil with an ounce of tincture of opium may be given to clear the bowels, after which a binding draught may be administered, if necessary, this consisting of powdered chalk, catechu, and opium, the doses being arranged by a good druggist. In bad cases, which may be described as dysentery, the fæces are mixed with blood ; there is great weakness, and inflammation of the organs of digestion. In such there must be prompt action, good nursing, and the best advice. Diarrhœa in calves is caused by acidity, chill, and careless feeding. In ordinary cases 1½ to 2½ oz. of castor oil may be given in accordance with the age and size of the animal, followed by periodical doses of a cordial containing powdered chalk, ginger, opium, and catechu. It is prepared by any good druggist. Many cases of diarrhœa are infectious, hence the importance of supreme cleanliness and isolation.

White Skit, or Scour. This is common among calves taking milk. In ordinary cases the oil and cordial may be given as above, but where the disease is the result of a bacillus, Nocard's system must be adopted. The animal shivers, there is rapid emaciation, and death. The discharge is very thin and a yellowish grey. Practically no treatment succeeds in effecting a cure. The one thing is to prevent its occurrence. The bacillus enters the system through the navel cord ; hence, when the cow is about to calve she should be kept in a disinfected box on clean straw. The cord of the calf after birth should be tied with thread 1½ to 2 in. below the navel, and cut an inch below the tie. The cord should then be dressed with a solution composed of 1 gramme of iodine crystals, 2 drachms of iodide of potash, with 500 cubic centimetres of water ($1\frac{1}{10}$ pints), and subsequently coated with a solution of 1 gramme of iodine crystals and 500 cubic centimetres of alcohol. This must be allowed to dry thoroughly, when a layer of 1 per cent. iodine collodium should be painted or coated over it, and well dried before the calf is released. Cows about to calve should be disinfected with a 2 per cent. solution of creolin in water. The hands of the operator and the knife and thread employed should be sterilised or disinfected.

Broken Horns. In bad cases the stump may be removed ; in others it may be smeared with the best Archangel tar, bound with tow, and subsequently with a clean cotton bandage.

Cowpox. Pustules appear upon the teats, being usually communicated by the hands of milkers ; hence the importance of cleanliness. The affected teats may be bathed with a mixture of ½ oz. of chloride of lime in two quarts of water.

Poisons. The most common vegetable poisons are yew and rhododendron ; but whether these have been eaten, or whether the animal has in some way consumed mineral poisons, the services of an expert are essential.

The pulse of a beast is taken at the jaw, 45 beats per minute ; while the temperature, which is taken in the anus, is 101° F.

DISEASES OF SHEEP

Anthrax and Foot and Mouth Disease. The remarks on these diseases under the head of Cattle apply also to sheep.

Foot-rot, Scab [1], and Vermin have also been referred to in our general remarks.

Catarrh. This is indicated by a running at the eyes and nostrils, sometimes with the addition of a cough, loss of condition, and refusal to feed. The animal should be isolated, nursed, kept warm, and fed with gruel, to which a drachm of nitre may be added from time to time.

Husk. This is accompanied by cough, weakness, and loss of weight. It should be promptly attended to, the affected animal being removed from the flock, which should be shifted on to a dry pasture and liberally fed. Lambs should not feed on grass over which older sheep have been running. The patient should receive a mixture of turpentine and olive oil, prepared by a druggist, and be fed, a small quantity at a time, on nutritious rations, as crushed oats, with a little finely broken linseed cake, and sweet hay-chaff, and gruel or milk, if necessary. The complaint is caused by the presence of a worm, *Strongylus filaria* [**10**].

Pneumonia. An attack of this disease is accompanied by fever, loss of condition, thirst, laborious breathing, and refusal to feed. It is caused by exposure and chill, and is dangerous. The strength should be maintained by the aid of spirits, two tablespoonfuls being given

in linseed tea, milk, or gruel, with a little ginger added. Expert advice is essential.

Trembles, or Louping Ill. This disease, which affects the nerves, is believed to be due to the presence of a fungoid parasite communicated through the sheep tick. Hence the importance of keeping the wool and skin free from parasites by dipping at least twice yearly. The symptoms are tremor and grinding of the teeth. The disease is very dangerous, and is seldom cured. Where a case occurs the flock should be moved on to a clean, pure pasture, supplied with salt, and liberally fed.

Staggers, or Sturdy. This is easily recognised by a peculiar movement of the head, while the animal turns in a circle. It is due to the presence of a parasite in the brain, *Cœnurus cerebralis*, which is communicated through the tapeworm of the dog. There is no effective cure. The animal had better be killed while the carcase possesses any value. Wet pastures should be avoided; the dogs of the farm kept healthy, and salt supplied to the flock.

Braxy. This is a highly fatal disease, which it is almost useless to treat. The head hangs, the back is rigid, and there is grinding of the teeth. The direct cause is believed to be found in bad feeding, especially on decomposing grass. A palliative is found in a supply of salt to the flock, and good sound pastures. The diseased sheep should be at once isolated, and a purgative in gruel may be tried, or a veterinarian called in, but in all cases slaughter is the most economical course to adopt.

Dysentery. This is recognised by abnormal, fetid droppings, mixed with mucus and blood, with fever, weakness, and refusal to feed. It may be caused by a chill. The sheep should be isolated, well fed on flour gruel, and in mild cases treated with powdered chalk and opium, the quantities in accordance with age, or the cordial recommended for scour in calves may be administered. All cases of looseness in sheep should be watched, and treated immediately.

Hoove. This results from fermentation of food and the production of gas, as in cattle. When a flock is placed on green food or roots, the allowance should be limited until they have become accustomed to the change. A purge of 3 oz. of Epsom salts with a little ginger is advisable, followed by oatmeal gruel, about 4 oz. at a time. If the symptoms do not abate, the trocar and canula may be used as for cattle.

Parturient Fever, or Straining after Lambing. This disease is the result of blood poisoning, often following delivery by the shepherd with hands which have not been disinfected. It is accompanied by fever, the discharge of a dark fluid, pain, and diarrhœa, and is highly dangerous. When assisting a ewe, the shepherd should take the greatest care to purify his hands with diluted carbolic acid, 1 part to 50 of pure water, and if necessary—indeed, it almost follows that it is necessary—the parts may be syringed with a mixture of 1 part of carbolic acid to 10 parts of glycerine. If the affected animal needs a stimulant, two or three tablespoonfuls of whisky or brandy at a time may be given in flour gruel, adding an ounce of tincture of opium if there is diarrhœa.

Liver Rot. This is caused by the action of an organism known as fluke (*Fasciola hepatica*). There is loss of condition, yellowness of the eye, falling off of wool, and diarrhœa. The organism passes through the system of the water snail; hence wet land should be avoided. The assistance of ducks on sheep farms with wet land has been advocated, the birds consuming the snails. On such land salt should always be liberally supplied. When fluke is suspected, the flock should be removed to dry land, and liberally and quickly fed for the table before it is too late. Salt marshes are advantageous.

Maggots. These pests usually appear in colonies during warm, moist weather, if the eggs deposited by the bluebottle fly are not removed or destroyed by the shepherd, who during summer should keep a strict watch on every sheep, especially noticing any action indicating discomfort. If neglected, the maggots will enter the skin, the wool will fall off, and the sheep become ragged and lose condition. Spirits of tar may be freely used.

The pulse of the sheep, which is taken at the heart, beats 75 times per minute, while the temperature of the body is 101° F. When medicine is administered, it should be from a small bottle with a long, narrow neck, the fluid being slowly and gently passed down the right side of the mouth and kept clear of the tongue.

DISEASES OF PIGS

The diseases of pigs which are notifiable to the police are swine fever, foot and mouth disease, and anthrax. The two latter have already been referred to in connection with cattle, and need no further description, the treatment being practically the same for pigs as for young cattle.

Swine Fever. This very destructive and contagious disease should be handled with promptitude and energy. Where any doubt occurs in diagnosis, the veterinary inspector or surgeon should be immediately called in. Affected swine show fever, great thirst, refusal to feed, and a skin patched with purple, especially on the belly. A case should be immediately isolated on presenting such an appearance, and on being declared as swine fever each animal affected should be slaughtered, and others which have been in contact with them isolated and treated under the advice of the Government inspector. Every place occupied by diseased pigs should be thoroughly disinfected. Even the boots of the pig-feeder, the vessels used for feeding, including troughs and pails, all should be cleansed with strong carbolic water.

Husk is a complaint due to the same cause as husk in cattle, and may be similarly treated.

Trichinosis. This parasitic disease, of which too little is known, is, happily, seldom found in his country; the only remedy—*i.e.*, to prevent it spreading—is slaughter.

Inflammation of the Lungs. This is due to exposure and chill, and is accompanied by a dry cough, abnormal breathing, and shivering. In cases where the disease is not severe, and where the condition hardly warrants

slaughter, the patient may be kept in a dry, warm sty and rapidly fed for the butcher. It may possibly be found that the liberal use of new milk with good meal will be followed by a rapid increase in weight and the prevention of any serious loss. An affected pig needs exceptionally good feeding and nursing, with dry warmth and plenty of air. A light blister, made by mixing mustard and turpentine, well rubbed over the affected part, is sometimes followed by good results, but this should be accompanied by medicine obtained from the veterinary surgeon.

Measles. This troublesome complaint is accompanied by fever, pustules under the tongue, and red blotches on the skin. The patient should be kept in a warm, dry, well-ventilated sty, supplied with good food, such as milk given slightly warm, together with an ounce of sulphur twice daily.

Rheumatism. This chiefly affects young pigs, which apparently become cramped, especially in the hind limbs. The complaint is caused by lying upon damp beds, hot manure heaps, or even cold stone, concrete, or brick floors with insufficient straw. Wooden benches well covered with dry wheat-straw should be provided, so that the animals can make themselves warm and comfortable. A mixture of turpentine and mustard may be rubbed well into the affected limbs.

Sore Throat. This is a serious complaint, often resulting in death. There is swelling on the throat or neck and tongue, while the membrane of the mouth becomes abnormally dark in colour. The pig rapidly loses condition and strength, and, unless the disease is arrested, death speedily follows. The throat may be fomented, Epsom salts administered at the outset, and the advice of a veterinarian obtained.

A USEFUL MEDICINE CHEST

The following materials should be kept in store by every stock-feeder. They chiefly consist of simple remedies or appliances which any intelligent man may employ upon recognising the complaint which they are intended to relieve. We think, however, that in all serious cases the preparation and administration of medicine should be left entirely to those who have been properly trained for the purpose. In deciding upon the employment of a veterinary surgeon, it may be well to arrange to pay for his services by an annual sum or by definite fees for each visit, to include medicine.

List of Medicines

Condy's Fluid	Carbolic acid (poison)
Tincture of ammonia	Nitre
Powdered aloes	Spirits of camphor
Epsom salts	Linseed oil
Castor oil	Olive oil
Mustard	Powdered ginger
Sulphur	Prepared chalk
Powdered catechu	Spirits of tar
Archangel tar	Sheep dip
Foot-rot ointment	Calf cordial

Instruments and Materials

Trocar and canula	Clamps for castration
Clinical thermometer	Twitches for horses
Knee-caps and bandages	Searing iron

INSECT PARASITES

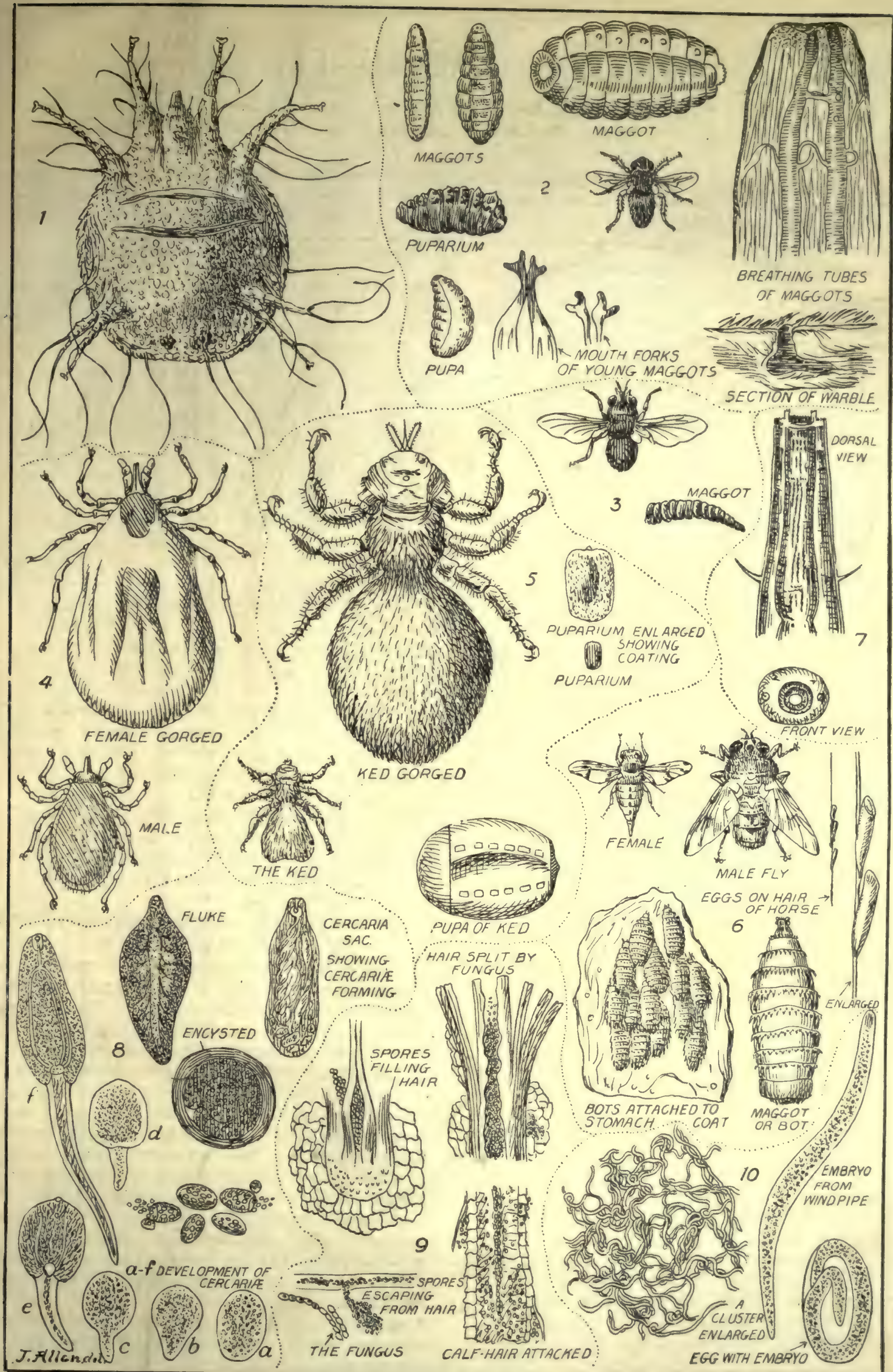
Ox Warble Fly (*Hypoderma lineata* and *H. bovis*). So terrible have been the ravages of this pest that the damage was once estimated by Ormerod to amount to millions of pounds sterling per annum, and the loss is still very great. The larvæ from the eggs of *H. lineata* [2] find their way into the body in a manner similar to the horse bot [see below], but after wandering through the connective tissue, finally lodge under the hide along the back, forming the well-known "warbles," the hide being perforated, and frequently riddled with the holes caused in this way. Not only may the hide be ruined, but much loss arises through falling off in the milk yield of a cow, or spoiling the carcase from the point of view of the butcher. Stock should have the natural shelter of trees if possible, and be near water which they can enter; while egg-laying by the fly may be prevented in summer by smearing the animals with a strong-smelling, greasy material such as cart-grease and paraffin, or a mixture of 1 quart of train-oil, 4 ozs. of oil of tar, and 4 ozs. of flowers of sulphur. All "bots" found in the backs of stock should be squeezed out and destroyed during the first four months of the year.

Horse Bot Fly (*Gastrophilus equi*). In this case the fly attaches its eggs [6] to the hairs of the neck, sides and shoulders, startling its victim in the act. Irritation is caused by the resulting larvæ, which are licked into the mouth of the horse, and finally find their way to the stomach and intestines, where they cause considerable irritation and inflammation, passing away in the fæces some months later. Rubbing down the horse with a paraffin cloth during June and July may prevent egg-laying. Close clipping should be resorted to, and the coat examined for eggs, which may be removed and destroyed, while infested animals should be well fed.

Sheep Ked and Sheep Tick. These two pests differ widely, though the former is frequently, although improperly, termed "tick." The ked (*Melophagus ovinus*) is a dipterous insect [5] which feeds on the blood and the fatty substance of the wool; the true tick (*Ixodes reduvius*), on the other hand, passes part of its life on vegetation [4], but at one stage it is parasitic on the sheep, sucking the blood in considerable quantity, while in the Border districts ticks act as intermediaries in causing the disease known as Louping Ill. For the ked dipping is resorted to, and is regularly carried out in practice [see also Sheep Scab]. All keds and ticks seen on sheep should be destroyed, and as a preventive measure for ticks the herbage may be burnt in spring, so destroying many ticks.

Among other insect pests of livestock may be mentioned the sheep maggot fly (*Lucilia sericata*), the maggots [3] of which invade the flesh of the back and rump, and are frequently very troublesome; the gad flies (*Tabanidæ*), which worry and startle livestock by sucking their blood and by loud buzzing; and lice (*Pediculidæ*), of which there are many species, young animals being chiefly infested.

Continued



LIVESTOCK PESTS

1. Sheep scab (*Psoroptes communis*) highly magnified 2. Warble fly (*Hypoderma lineata*) 3. Sheep maggot fly (*Lucilia sericata*) 4. Sheep tick (*Ixodes reduvius*) enlarged 5. Sheep ked (*Melophagus ovinus*) enlarged 6. Horse bot fly (*Gastrophilus equi*) 7. Horse worms (*Sclerostomum tetracanthum*) 8. Liver fluke (*Distomum hepaticum*) 9. Ringworm of cattle (*Trichonophyton tonsurans*) 10. Husk-worm (*Eustrongylus filaria*)

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SPANISH—ITALIAN—FRENCH—GERMAN

Spanish by Amalia de Alberti; Italian by F. de Feo; French by Louis A. Barbé, B.A.; German by P. G. Konody and Dr. Osten

SPANISH Continued from page 2484

By Amalia de Alberti

ADJECTIVES—continued

Degrees of Comparison. Spanish adjectives have the usual degrees of comparison—positive, comparative, and superlative.

The comparative is formed by adding *más* (more) to the positive. The superlative is formed by adding *muy* (very) to the positive, or by the addition of *ísimo*. Terminal vowels are dropped before this addition. Thus:

Positive.	Comparative.
vil, vile	*más vil*, more vile
prudente, prudent	*más prudente*, more prudent

Superlative.

muy vil, vilísimo, most or very vile
muy prudente, prudentísimo, most or very prudent

The superlative in this form expresses the quality in an absolute degree, but without comparison; when comparison is intended, *el más, la más,* or *lo más*, the most, is used, according to gender, as: *el más prudente*, the most prudent.

Note. The neuter article *lo* can be used with any superlative to which the word "thing" or any other word may be added in English, as: *Lo mejor no es siempre lo más divertido,* the best (thing) is not always the most amusing; *lo más fácil no es siempre lo mejor*, the easiest (way) is not always the best.

Adjectives ending in *ble* change the last syllable into *bilísimo* in the superlative, as: *amable*, amiable, *amabilísimo.*

Some adjectives ending in *iente* drop the *i* in the superlative:

Positive.	Superlative.
ardiente, ardent	*ardentísimo*
ferviente, fervent	*ferventísimo*
luciente, bright	*lucentísimo*

Adjectives ending in *z, co*, and *go* take *císimo, quísimo*, and *guísimo* in the superlative, as: *feliz*, happy, *felicísimo; rico*, rich, *riquísimo; vago*, vague, *vagísimo.*

The following are some of the irregular superlatives:

fuerte, strong, *fortísimo*
cruel, cruel, *crudelísimo*
antiguo, ancient, *antiquísimo*
célebre, celebrated, *celebérrimo*
magnífico, magnificent, *magnificentísimo*
nuevo, new, *novísimo*
sagrado, sacred, *sacratísimo*
sabio, wise, *sapientísimo*

The comparative of superiority is expressed by *más* (more), *que* (than), thus: *Yo tengo más dinero que mi hermano*, I have more money than my brother.

The comparative of equality is expressed by *tan* (as), *como* (as), or *tanto, como: Hay tanto oro como plata,* there is as much gold as silver; *tan blanco como la nieve*, as white as snow.

The comparative of inferiority is expressed by *menos* (less), *que* (than): *Tiene menos hijos que hijas*, he has fewer sons than daughters.

When "the more" and "the less" are repeated in a sentence they are rendered by *cuanto más, tanto más, cuanto menos, tanto menos: Cuanto más tenemos tanto más queremos,* the more we have the more we want; *cuanto menos tenemos tanto menos necesitamos*, the less we have the less we need.

Besides the comparative and superlative formed according to the rule, the following adjectives have also an irregular form:

Positive.	Comparative.
bueno, good	*mejor*, better
malo, bad	*peor*, worse
grande, great	*mayor*, greater
pequeño, little, small	*menor*, less, smaller
alto, high	*superior*, higher, superior
bajo, low	*inferior*, lower, inferior

Superlative.

optimo, very good
pésimo, very bad
maximo, very great
mínimo, very little, very small
supremo, supreme, very high
infímo, very low

DIMINUTIVE AND AUGMENTATIVE SUFFIXES

Diminutive and augmentative suffixes are terminations applied to nouns and adjectives modifying their original meaning. Their correct use can only be learned by practice.

Diminutives express smallness in size, affection, pity, or contempt. The chief diminutives are *ico, cico, cito, ecito*—these denote affection, and are always well meant—and *illo, cillo, zuelo*, which denote smallness in size, pity, or contempt. All these diminutives take *a* in the feminine.

Augmentatives express largeness in size, clumsiness, contempt, and disproportion. The chief augmentatives are: *on, azo, ote*, in the masculine, and *ona, aza, ota* in the feminine (these express augmentation only); and *acho, achón*, and *arrón*, which further express clumsiness and contempt.

A double augmentative is sometimes used, as: *picaron*, rogue; *picarono* and *picaronazo*, a great rogue.

Note. All words ending in *azo* are not augmentatives; many denote a blow with some weapon, expressed by adding *azo* to the noun, as: *fusil*, gun; *fusilazo*, a gunshot; *pistola*,

pistol; *pistoletazo,* pistol-shot; *baston,* stick; *bastonazo,* a blow with a stick. A blow with a sharp weapon is generally expressed by adding *ada* to the noun, as: *puñal,* dagger; *puñalada,* a dagger thrust; *lanza,* lance; *lanzada,* a wound with a lance.

Diminutives are constantly applied to proper names, as: *Juan,* John; *Juanito,* Johnnie; *Juana,* Jane; *Juanita,* Jenny; *Ana,* Anne; *Anita,* Annie.

Vocabulary	**Vocabulario**
To take a journey	Ir de viaje
The portmanteau, the dress-basket	La maleta, el mundo
The bag	El saco
To pack	Empaquetar
The carriage to go to the station	El carruage para ir a la estacion
First - class tickets, second-class tickets for the servants	Los billetes de primera clase, los billetes de segunda clase para los criados
The compartment	El compartimiento
The guard	El guarda
To eat or dine in the train	Comer en el tren
To sleep in the train	Dormir en el tren
A reserved compartment	Un compartimiento reservado
To take (with one) a courier and a lady's maid	Llevar consigo un courrier y una doncella
To reach one's destination	Llegar á su destinacion
The hotel	El hotel
To take tickets for the opera	Tomar billetes para la opera
To go to the theatre	Ir al teatro
To go to the shops, to the haberdasher's, to the draper's	Ir á las tiendas, á la merceria, á la tienda de mercader
Silk	Seda
Cloth	Paño
Lace	Encaje
Handkerchiefs	Pañuelos
To go to the confectioner's to eat pastry and ices, and drink lemonade	Ir á la confiteria comer pasteles, y helados, y beber limonada
To spend the carnival in Rome, to see the fêtes and masks, which last three days	Pasar el carnaval en Roma, ver las fiestas, y las máscaras que duran tres dias
Ash Wednesday. Let us stay in Rome for Easter Sunday	El Miércoles de ceniza. Quedemos en Roma para Pascua de Resureccion.
To go to the Vatican	Ir al Vaticano
To have an audience with the Pope	Tener una audiencia del Papa
To go to Court. To be received by the king and the queen	Ir á la corte. Ser recibido por el rey y la reina
To go to the balls at the English Embassy	Ir á los bailes de la Embajada inglesa
To count one's money	Contar su dinero
To admire the pictures and sculptures	Admirar las pinturas y las esculturas
To go from Rome to Naples, Florence, and Venice	Ir de Roma á Napoles, Florencia, y Venecia
To take a gondola	Tomar una góndola
To come home tired, and dismiss the courier	Volver á casa cansado, y despedir al courrier

EXERCISE V. (1).

Translate the following into Spanish:

1. Let us go [a] journey; pack the portmanteau and the dress-basket with care. 2. At what time [is] (the carriage [2]) ordered [1]? For eight o'clock. 3. Who is going to take the tickets? The courier (is going [2] to take) them [1]. 4. [Is] (the compartment [2]) reserved [1]? Yes, sir. 5. What hotel shall we go to? To the Bristol Hotel. 6. I have taken tickets for the opera. 7. I have bought two silk [2] dresses [1], and one of cloth, then [2] (I went [1]) to the confectioner's to eat some delicious [2] pastry [1]. 8. We were fortunate to obtain a private [2] audience [1] of the Pope. 9. The king and queen are very amiable. 10. We have spent a lot; let us count our money. 11. I am glad to come home; I am tired; there is the courier to dismiss.

Vamonos . . . . . . ; empaquete . . . . con cuidado. . . A que hora . . . . se ha ordenado ? . . . las ocho. . . . . . . Quien va á tomar . . . . . . ? . . . . los. . . . . se ha reservado ? . . . . A que . . . . iremos ? . . . . He tomado. . . . . He comprado dos . . . . fué . . despues . . . . deliciosos. . . . . Fuimos afortunados obtener privada . . . . Hemos gastado . . . ; contamos nuestro . . . . . . Me alegro . . . . ; estoy . . . ; hay que . . . .

EXERCISE V. (2).

Translate the following into English:

1. Ese hombre es rico, pero su hermano es más rico; su padre es muy rico, y su tio riquísimo. 2. Esa mujer es amable; su hermana amabilísimo. 3. El amor es ardiente; es ardentísimo á veces. 4. Las estrellas son lucientes; el sol es lucentísimo. 5. El caballo es fuerte; la mula es fortísima. 6. La muerte es cruél, cruélísima. 7. Esta estatua es antigua, antiquísima. 8. Sócrates fué sapientísimo. 9. Ese niño es pequeño, este es menor. 10. Este hombre es sabio, pero su padre es superior en sabiduría.

That . . . . his . . . . uncle. . . . . was . . . . this one . . . . wisdom.

PROSE EXTRACT V.

From "La Hora de Todos y la Fortuna con Seso" ("The Hour of All, and Fortune no Fool"), by Francisco de Quevedo

FORTUNE'S ANSWER TO THE ACCUSATIONS OF JUPITER

"If the deserving are put on one side, and the virtuous left unrewarded, it is not all my fault; many despise what I offer them, and you blame me for their moderation. Many, for want of putting out their hand to take my gift, let it pass to others who snatch what I never gave. Those who do me violence are more numerous than those whom I make rich. More steal what I deny them than keep what I give them. Many receive from me what they do not know how to keep; they lose it, and say that I took it away from them. Many accuse me of bestowing evilly upon others what had been worse bestowed upon themselves. No man is happy without the envy of many, and no man is unhappy without the contempt of all. This servant has served me constantly; I have not moved a step without her; her name is Occasion; hear her and learn how to judge from a kitchen-wench."

Then said Occasion, reeling her speech off quickly, for fear of inculpating herself: "I am a woman who offers herself to all; many find me, but few make the most of me; I am a female Samson whose strength is in her hair. He who can hang on to my mane knows how to defend himself from the twists and turns of my mistress. I divide and dispose of her gifts, and I am accused because men do not know how to gather them up and enjoy them. Stupidity has scattered these infernal phrases among men: 'Who would have thought it; I did not think; I never noticed; that's all right; what does it matter; that's neither here nor there; to-morrow will do; there's lots of time; there's sure to be a chance; let me alone; I know what I'm about; I'm no fool; let it alone; I can do without it; laugh at all things; I don't believe it; I am sure to get the best of it; it will not fail; the Lord will provide; days are more plentiful than sausages; when one door shuts another opens; that's well and good; what business is it of his; it seems to me; it is not possible; don't tell me; I know all about it; facts will prove; let the world wag; I owe God a death; I should cut a pretty figure; why, certainly; let them say what they like; in for a thousand, in for a thousand five hundred; I can turn my hand to anything; my heart in my hand; we shall see; and what, and but, and perhaps.' And the motto of the obstinate, 'I will go my own way.' These stupidities make mankind presumptuous, lazy and careless."

CONTESTACION DE LA FORTUNA CONTRA LAS ACUSACIONES DE JUPITER

"Si hay beneméritos arrinconados y virtuosos sin premios, no toda la culpa es mia; á muchos se les ofrezco que los desprecian, y de su templanza fabricáis mi culpa. Otros, por no alargar la mano á tomar lo que les doy lo dejan pasar á otros, que me lo arrebatan sin dárselo. Mas son los que me hacen fuerza que los que yo hago ricos; mas son los que me hurtan lo que les niego que los que tienen lo que les doy. Muchos reciben de mi lo que no saben conservar, piérdenlo ellos y dicen que yo se lo quito. Muchos me acusan por mal dado en otros lo que estuviera peor en ellos. No hay dichoso sin invidia de muchos, no hay desdichado sin desprecio de todos. Esta criada me ha servido perpetuamente; yo no he dado paso sin ella; su nombre es la Ocasion; oidla, aprended á juzgar de una fregona."

Y desatando la taravilla la Ocasion, por no perderse á si misma dijo: "Yo soy una hembra que me ofrezco a todos; muchos me hallan, pocos me gozan; soy Sansona femenina, que tengo la fuerza en el cabello. Quien sabe usirse á mis crines sabe defenderse de los corcovos de mi ama. Yo la dispongo, yo la reparto, y de lo que los hombres no saben recoger y gozar, me acusan. Tiene repartidas la necedad por los hombres estas infernales cláusulas: 'Quien dijera, no pensaba, no miré en ello, no sabia, bien está, qué importa, qué va ni viene, mañana se hará, tiempo hay, no faltará ocasion, descuidéme, yo me entiendo, no soy bobo, déjese deso, yo me lo pasaré, ríase de todo, no lo crea, salir tengo con la mia, no faltará, Dios lo ha de proveer, mas dias hay que longanizas, donde una puerta se cierra otra se abre, bueno está eso, que le va á él, paréceme á mi, no es posible, no me diga nada, ya estoy al cabo, ello dirá, ande el mundo, una muerte debo á Dios, bonito soy yo para eso, si por cierto, diga quien dijere, preso por mil, preso por mil y quinientos, todo se me alcanza, mi alma en mi palma, ver veamos, y que, y pero, y quizas.' Y el tema de los porfiados, 'Dé donde diere.' Estas necedades hacen a los hombres presumidos, perezosos y descuidados."

Francisco de Quevedo (1580-1655), poet and satirist. His reputation rests chiefly upon his prose satires, especially upon a series of six called "Visions." In the apologue, from which the above extract is taken, Jupiter summons Fortune before him, and rates her for her injustice towards mankind. After hearing her defence, he resolves to apportion his

Francisco de Quevedo (1580-1655), poeta y satirico. Su reputacion resta principalmente en su prosa sátirica, especialmente sobre una série de seis llamadas "Sueños." En el apólogo del cuál el extracto que precede ha sido tomado, Jupiter cita á la Fortuna y la reprueba por su injusticia hacia la humanidad. Despues de oir su defensa toma la resolucion de

true deserts to every human being for the space of one hour. Such intolerable confusion is the result that Jupiter restores the empire of Fortune, and all is allowed to go on as before.

repartir y dar por una hora á todo ser humano lo que cada cual merece. Resulta tal intolerable confusion que Jupiter restora el imperio de la Fortuna, y es permitido que todo siga como anteriormente.

KEY TO EXERCISE IV.

1. Ese hombre es *grande* y esa mujor es tambien *grande*.
2. Ese edificio es hermoso, y esa estatua es *hermosa*.
3. Un *traidor* á su patria. Una *traidora* á su fé.
4. Un español, una española, un inglés y una inglesa hablaban sin entenderse.
5. Un amo *bueno*, y un *buen* criado son raros.
6. La hacienda es productiva.
7. Los toros son bravos.
8. Los potros son numerosos.
9. Las mulas son fuertes.
10. El hacendero es rico.
11. Los labradores son honrados.
12. El gallo canta por la mañana, las gallinas cacarean.
13. La leche y la manteca son frescas.
14. El cazador es buen tirador.
15. La caza es abundante.
16. Los ciervos son ligeros.
17. Los osos y los jaabalies son feroces.
18. El guarda es vigilante.
19. Las medias son de seda, y los zapatos de piel fina.
20. El pañolon es de lana, y tambien lo son los calcetines.
21. Los guantes son de piel de perro.
22. El sastre ha traido mi paletó y mi levita.
23. La costurera ha traido mi vestido.
24. La modista ha traido mi sombrero, y el guantero mis guantes.
25. Buenos días, señor! Buenos días, señora!
46. El colegio es bueno.
27. Tiene una hermosa libreria, y unos libros splendidos.
28. Los manuscritos son antiguos.

Continued

ITALIAN

Continued from page 2486

By Francesco de Feo

ADJECTIVES

The adjective agrees with the noun in gender and number.

The gender of the adjective is known by its termination.

Adjectives in Italian either end in *o* (*buono*) or in *e* (*diligente*).

1. The form in *o* is used for the masculine gender, as: *vino buono*, good wine; *uomo ricco*, rich man. This form has a corresponding feminine form in *a*, as: *gente buona*, good people; *persona ricca*, rich person.

2. The form in *e* is used both for the masculine and feminine, as: *scolaro diligente*, diligent pupil; *scolara diligente*.

The qualifying adjective is placed *before* the noun when it expresses an innate quality of the noun, as: *la verde campagna*, the green country; *le alte montagne*, the high mountains. It is placed *after* the noun when it expresses a casual and accessory quality of the noun, as: *un cielo sereno*, a clear sky; *un cielo nuvoloso*, a cloudy sky; *un bagno freddo*, a cold bath; *un bagno caldo*, a hot bath.

NOTE. There are occasional departures from this simple rule, especially when the adjective is used emphatically.

READING EXERCISE [ESERCIZIO DI LETTURA]

Ma la pràtica [1] generale ha voluto [2] che òbblighi [3] soltanto a non confidare [4] il segreto, se non a chi sia un amico ugualmente fidato [5], e imponèndogli [6] la stessa condizione. Così [7], d'amico fidato in [8] amico fidato, il segreto gira e gira [9] per quell' immensa catena, tanto che [10] arriva all' orècchio di colui o di coloro [11] a cui il primo che ha parlato intendeva appunto di non lasciarlo arrivàr mai [12]. Avrebbe però [13] ordinariamente a stare [14] un gran pezzo in cammino [15], se ognuno non avesse che [16] due amici: quello che gli dice, e quello a cui ridice la cosa da tacersi [17]. Ma ci son degli uòmini privilegiati che [18] li [19] còntano [20] a centinaia; e quando il segreto è venuto a uno [21] di questi uòmini, i giri divengon sì ràpidi e sì moltìplici, che non è più possìbile di seguirne la tràccia. [22]

NOTES. (Expressions have been chosen which correspond as nearly as possible with the exact meaning of the Italian words): 1. Practice. 2. Determined. 3. That [the condition] binds [the friend]. 4. Not to confide. 5. Unless it be to one who is an equally confidential friend. 6. Binding him also (by). 7. Thus. 8. From confidential friend to. 9. Travels and travels along. 10. So much that. 11. It arrives at the ears of the person or persons (*colui o coloro*). 12. Particularly intended never to allow it to arrive. 13. However. 14. To be. 15. A long while on its way. 16. If everyone had only. 17. The one who tells him, and the one to whom he repeats the thing to be kept secret. 18. Who. 19 Them. 20. Count. 21. Has reached one. 22. Its travels become so rapid and so manifold that it is no longer possible to follow their traces.

Plural of Adjectives. In the formation of the plural the adjectives follow the general rule given for the substantives:

1. Adjectives ending in *o* and in *e* form their plural by changing the *o* and *e* into *i*, as: *buono, buoni; caro, cari; diligente, diligenti; prudente, prudenti.*

2. Adjectives ending in *a* form their plural by changing the *a* into *e*, as: *buona, buone; cara, care.*

The adjective *pari* is indeclinable: *I pari miei,* men such as I; *le pari mie,* women such as I, etc.

For the adjectives ending in *co, go, ca, ga, io,* see the observations on the plural of nouns.

If the adjective refers in the same sentence to nouns of different genders, it is put in the masculine gender.

NOTE. All the adjectives in Italian may be used as substantives—*e.g.*: *gli uomini buoni,* or simply *i buoni; gli uomini cattivi,* or simply *i cattivi; un uomo Inglese,* or, which is better, *un Inglese.*

Observations on Certain Adjectives. *Bello* (beautiful, fine) follows the same rules as the article *lo*—*i.e.,* before masculine nouns beginning with a consonant (except *z, gn,* and impure *s*) it drops the syllable *lo* in the singular, and becomes *bei* (often written *be'*), in the plural, as: *un bel regalo* (a nice present), *dei bei regali; un bel cavallo* (a beautiful horse), *dei bei cavalli.* Before a vowel, in the singular, the final *o* is dropped and the apostrophe is put instead, as: *un bell' orologio,* a fine watch. Before a vowel, *z, gn,* and impure *s* in the plural it becomes *begli,* as: *begli occhi,* beautiful eyes. Before feminine nouns it is regular: *bella mano.*

Belli is used only as predicate: *I fiori sono belli.*

Buono (good) in the singular follows the same rules as the indefinite article: *buon uomo, buon libro, buona donna, buono scolaro, buono zio, buon' anima.* In the plural it follows the general rule, as: *buoni uòmini, buone zie,* etc.

Grande (big) becomes *gran* before a consonant and *grand'* before a vowel, as: *gran libro, grand' uomo; gran* (or *grande*) *spettàcolo, gran* (or *grandi*) *spettàcoli.*

Santo (saint) becomes *san* (masculine) before a proper name beginning with a consonant, and *sant'* before a vowel, as: *san Giòrgio, sant' Andrea.*

Frate (friar) may become *fra* before a consonant, as: *fra Cristòforo.*

Signore (Mr.) drops the final *e* before proper names, as: *Signòr Tale.*

EXERCISE XII.

biondo (*bee-òndo*), fair	*neve* (*nèhveh*), snow
bianco (*bee-àhnco*), white	*inverno* (*een-vèhrno*), winter
nero (*nehro*), black	*estate* (*eh-stàhteh*), summer
rosso, red	*finestra* (*feenèhstrah*), window
verde (*vèhr-deh*), green	*barba,* beard
fedele (*fehdèh-leh*), faithful	*mondo,* world
turchino (*toorkeèno*), blue	*bandiera* (*bahndee-èh-rah*), flag
lungo (*loòngo*), long	*letto* (*lèhtto*), bed
corto, short	
stanco, tired	

1. Una casa bianca. 2. La bianca neve. 3. Il freddo inverno. 4. Un abito nero. 5. Capelli neri. 6. Quella ragazza ha gli occhi turchini e i capelli biondi. 7. Nella grande strada a destra vi è un gran bel palazzo con le finestre verdi. 8. I ricchi hanno sempre amici fedeli. 9. Il leone e la tigre sono animali feroci. 10. Fra Cristoforo aveva la barba bianca e lunga. 11. Gli àlberi sono càrichi di frutta. 12. Nel mondo vi sono i buoni e i cattivi. 13. Bianco rosso e verde sono i colori della bandièra italiana. 14. La nostra casa è in via sant' Andrea. 15. La figlia della padrona di casa ha begli occhi, ma brutti capelli. 15. Le giornate sono corte d'inverno e lunghe d' estate. 17. I ragazzi e le ragazze sono andati a letto, perchè èrano molto stanchi.

Demonstrative Adjectives. The demonstrative adjectives are: *questo* (this), *codesto* (that . . . of yours), *quello* (that), *stesso, medèsimo* (same), *tale* (such), *altro* (other), *quale?* (which ?).

Questo indicates a person or thing near or considered as near the person who is speaking, as: *questo cappello, questo libro. Sta* in some cases stands for the feminine *questa,* and is generally written in one word with the noun, as: *stasera* (this evening), for *questa sera; stamattina* (this morning), for *questa mattina.*

Codesto indicates a person or thing near or considered as near the person who is listening, as: *codesto orologio, codesto àbito.*

Quello indicates a person or thing distant, or considered as distant, from both the person who is speaking and the one who is listening, as: *quell' uomo* (that man), *quel quadro* (that picture).

Questo and *codesto* form their feminine and plural regularly: *questi libri* (these books), *codeste parole* (those words . . . of yours). *Quello* has the same forms as *bello: quel libro, quello scolaro, quei libri, quegli scolari, quell' erba, quell' uomo; un libro come quelli* (a book like those).

Questo and *quello* represent also the English the latter, the former, respectively, as: *Ho ricevuto un libro inglese e un libro italiano; quello non lo capisco, questo l' ho già letto* (I have received an English book and an Italian one; the former I do not understand, the latter I have already read).

As in English these adjectives never take the article: *a quest' ora, di quel tempo. Lo stesso, il medèsimo* are used as in English: *la medèsima cosa,* the same thing; *allo stesso tempo,* at the same time.

Stesso and *medèsimo* represent also the English *myself, himself, herself,* etc., in expressions like: *L' ho visto io stesso,* I have seen it myself; *La signora stessa l' ha detto,* the lady herself has told it.

Tale is often the correlative of *quale* (plural *tali* and *quali*). Example: *Tal* (*e*) *padre, tal*(*e*) *figlio* (like father, like son).

Quale i' fui vivo, tal son morto (Dante Inf., c. xiv., v. 51), Such as I was when alive, such I am also now that I am dead.

Altro is used as in English. Example: *Credevo che fossi un altro uomo,* I thought you were another man. *Pòrtami il libro,* bring me the book. *Èccolo,* here it is. *No; non questo, l'altro,* no; not this one, the other.

EXERCISE XIII.

1. Questo bagàglio, non quello. 2. Questi fiori sono per voi. 3. Codeste parole sono molto cortesi. 4. Abbiamo detto tutt' e due (both) la

stessa cosa. 5. Quegli scolari non hanno carta. 6. Queste case e questi giardini sono d'un Inglese. 7. Gli alberghi in questa città non sono molto còmodi. 8. Quei quadri e quelle stàtue sono l'òpera d'un grand' artista. 9. Quanto (how much) avete pagato codesto bastone? è molto bello. 10. Io non rispondo (answer), perchè codesti discorsi non m'interèssano. 11. Misi (I put) io stesso la lèttera alla posta, eppure l'avvocato ha detto che non l'ha ricevuta. 12. Queste frutta non sono mature; non sono le stesse che (which) avete mandate a casa stamattina.

Key to Exercise XI.

1. If I had. 2. If I had not? 3. That he (may) have. 4. That he (may) be. 5. That you (may) be. 6. If we were not? 7. If I were not. 8. They would be. 9. They would have had. 10. If I had had time, I would have come. 11. If I were . . . I would have. 12. He would be . . . if they had not been . . . 13. If I have time (literally, having time) . . . I shall be . . . 14. They are poor, but (they) would be rich, if (they) had had . . . 15. To have. 16. Of having. 17. Have patience. 18. Be good.

Continued

FRENCH Continued from page 2488 **By Louis A. Barbé, B.A.**

RELATIVE PRONOUNS

There are two forms of relative pronouns, the uninflected and the inflected.

The uninflected relative pronouns are:

qui, who, which, that, whom (after a preposition); *que*, whom, which, that; *quoi*, which; *dont*, whose, of whom, of which; *où*, in which, into which, at which, to which, etc.

The inflected relative pronouns are:

lequel (mas. sing.), *lesquels* (mas. pl.), who, whom, which, that; *laquelle* (fem. sing.), *lesquelles* (fem. pl.), who, whom, which, that.

The definite article is contracted in the same way as when it precedes a noun: *duquel, auquel, desquels, auxquels, desquelles, auxquelles.*

The relative pronoun, whether inflected or uninflected, is of the same gender, number, and person as its antecedent. In the case of the uninflected relative, there is nothing in the pronoun itself to show this agreement; but it affects the number and person of the verb of which the relative is the subject, and the number and gender of adjectives and past participles referring to the relative: *Les amis qui nous accompagnent connaissent bien Paris,* The friends who accompany us know Paris well.

Il y a dans ce livre une histoire qui est très intéressante, In that book there is a story which is very interesting.

1. *Qui*, as the subject of a verb, may refer to either persons or things:

Le marchand qui vous a vendu ces objets est très accommodant, The shopkeeper who sold you those objects is very obliging;

Il donne de l'eau à son cheval qui est très altéré, He is giving water to his horse, which is very thirsty.

When preceded by a preposition *qui* refers to persons only. For animals and inanimate objects the inflected relative must always be used after a preposition:

L'enfant à qui tout cède est le plus malheureux, The child to whom everything (every one) yields is the most wretched.

C'est une condition sans laquelle je ne consentirai à rien, That is a condition without which I shall not consent to anything.

2. *Que* is used as a direct object (accusative), and may refer to persons or things:

Voici les amis que nous attendions, Here are the friends we were expecting.

Je lis le livre que vous m'avez prêté, I am reading the book which you lent me.

The *e* of *que* is elided before a word beginning with a vowel or unaspirated h.

The *i* of *qui* is never elided; consequently, *qu'* always stands for *que*:

J'ai reçu la lettre qu'il m'avait promise, I have received the letter which he had promised me.

In English, the relative pronoun has distinct forms for subject and object only when it refers to persons: "who," "whom." When it refers to animals or things, it has only the one form "which" for both cases.

The fruit which is on that tree (nominative).

The fruit which that tree produces (objective).

In French, each case having its special form and not being dependent on position, the object is frequently placed immediately before the verb. Thus, "The fruit which that tree produces" may be rendered either by:

Le fruit que cet arbre produit, or *Le fruit que produit cet arbre.*

In English, the relative pronoun as object is very often omitted. In French it must always be expressed:

The pupil you have scolded, *L'élève que vous avez grondé;*

The exercises you have corrected, *Les devoirs que vous avez corrigés.*

3. *Quoi* is used as an indirect object—*i.e.*, after a preposition. Its antecedent is rarely a noun, but rather a statement, or some indefinite expression, such as *quelque chose,* something; *rien,* nothing; *voilà,* that is:

Il n'y a rien sur quoi l'on ait plus écrit, There is nothing about which more has been written.

Voilà de quoi je voulais vous parler, That is what I wished to speak to you about.

If the antecedent is a noun it is better to use the inflected relative with the preposition:

C'est la chose à laquelle je pense le moins, That is the thing I think least about.

4. *Dont* is equivalent to the relative pronoun and the preposition *de* (of, from), thus:

Le livre dont vous m'avez fait présent, The book of which you have made me a present.

Les amis dont vous avez méprisé les conseils, The friends whose advice you have despised.

In English, the noun dependent on "whose" always follows it, whether it be subject or object, and is never accompanied by a definite article. In French, it has always a definite article, and comes immediately after *dont* only when it is the subject of the relative clause. If it is the object of that clause it comes after the verb:

La maison dont le gérant m'a écrit, The firm whose manager has written to me;

La maison dont j'ai vu le gérant, The firm whose manager I have seen.

When "whose" is preceded by a preposition, it cannot be translated by *dont.* The inflected form of the relative must be used:

La maison au gérant de laquelle j'ai écrit, The firm to whose manager I have written.

5. *Où,* though really an adverb, is frequently used as the equivalent of a relative and one of the prepositions "in," "into," "at," "to," etc.:

La maison où il est né, The house where (in which) he was born.

It may be preceded by *de,* and used instead of *dont,* to indicate "place whence":

Le village d'où nous venons, The village from which we come.

Only *dont,* and not *d'où,* must be used to indicate descent:

La famille dont il descend est honorable, The family from which he descends is honourable.

NOTES. The relative pronoun with *ce* as its antecedent forms the absolute "what":

Ce qui est vrai n'est pas toujours agréable, What is true is not always pleasant.

Je vous répète ce que l'on m'a dit, I repeat to you what I have been told.

Prenez ce dont vous avez besoin, Take what you have need of.

When the verb is in the infinitive, "what" is *que:*

Je ne sais que faire, I do not know what to do.

The demonstratives *celui, celle, ceux, celles,* are used before the relative instead of the English personal pronouns, "he," "she," "they," and also instead of "the one":

Le meilleur ami est celui qui nous dit la vérité, The best friend is he who tells us the truth.

The demonstrative antecedent may be omitted, as in English:

Qui vivra verra, He who lives (long enough) shall see.

When "which" has a whole clause for its antecedent in English, the relative must be preceded by *ce* in French:

J'ai perdu ma valise, ce qui est fort contrariant, I have lost my portmanteau, which is very provoking.

INTERROGATIVE PRONOUNS

The interrogative pronouns are:

Qui? who? whom? *De qui?* whose? *À qui?* whose? *Qu'est-ce qui? Quoi?* what? *Lequel? lesquels?* (mas.), which? which one? *Laquelle? lesquelles?* (fem.) which? which ones? *Que? qu'est-ce que?* what?

1. *Qui,* as an interrogative pronoun, is both subject and object:

Qui vous a donné cela? Who gave you that?

Qui cherchez-vous? Whom are you looking for?

Qui? may be preceded by a preposition:

Pour qui me prenez-vous? For whom do you take me?

There is also a periphrastic form:

qui est-ce qui? who?
qui est-ce que? whom?

Qui est-ce qui vous a donné cela? Who (is it who) has given you that?

Qui est-ce que vous cherchez? Whom are you looking for?

When this form is used no inversion of the subject and verb is required to mark the interrogation.

"Whose?" is never expressed by *dont.* When it denotes ownership and is equivalent to "to whom belongs?" it is rendered by *à qui?*

Whose key is this? *à qui est cette clef?*

In any other case *de qui?* is used:

De qui est-il (le) fils? Whose son is he?

2. *Qu'est-ce qui?* "What" as the subject of an interrogative sentence has only the periphrastic form, *qu'est-ce qui?*:

Qu'est-ce qui vous empêche de venir avec nous? What prevents you from coming with us?

In indirect questions it becomes *ce qui:*

Je vous demande ce qui vous empêche de venir avec nous. I ask you what prevents you from coming with us.

3. *Que?* what? is used as the object or the predicate of a verb:

Que dites-vous? What do you say? *Qu'est-ce?* What is it? *Qu'est-il?* What is he?

Que deviendrons-nous? What will become of us? (What shall we become?)

There are also two periphrastic forms:

Qu'est-ce que? and *qu'est-ce que c'est que?* neither of which requires inversion of subject and verb:

Qu'est-ce qu'il dit? What does he say?

Qu'est-ce que c'est que ça (cela)? What is that?

In indirect questions *qu'est-ce que* becomes *ce que:*

Je vous demande ce que vous faites, I ask you what you are doing.

4. *Quoi?* is usually the indirect object of an interrogative sentence, and is preceded by a preposition:

Avec quoi avez-vous ouvert ce tiroir? With what have you opened that drawer?

It may also be used absolutely as either the subject or the object of a verb understood:

Il y a quelque chose dans ce tiroir. Quoi? There is something in that drawer. What?

J'ai mis quelque chose dans ce tiroir. Quoi? I have put something into that drawer. What?

Quoi? followed by an adjective in the comparative, preceded by *de*, is used as the subject of *est* understood:

Quoi de plus honteux que le mensonge? What more shameful than lying?

Quoi? may also be used, as more emphatic than *que?* with a verb in the infinitive:

Quoi faire? What to do (is to be done)?

5. *Lequel? laquelle? lesquels? lesquelles?* which? which of? express distinction or selection:

Lequel de vos frères vous a écrit? Which of your brothers has written to you?

De ces deux montres laquelle préférez-vous? Of these two watches, which do you prefer?

"What" Relative or Interrogative

The various ways of translating "what," whether relative or interrogative, are:

1. *Quel, quelle, quels, quelles.*

Quel livre lisez-vous? What book are you reading?

Quelle heure est-il? What time is it?

Quels sont les quatre points cardinaux? What are the four points of the compass?

Quelles belles gravures! What fine engravings!

Je ne sais pas quels romans vous avez lus, I do not know what novels you have read.

2. *Qu'est-ce qui, ce qui, ce que.*

Qu'est-ce qui vous empêche de sortir? What prevents you from going out?

Je vous demande ce qui vous empêche de sortir, I ask you what prevents you from going out.

Je sais ce que je veux, I know what I want.

3. *Que, qu'est-ce, qu'est-ce que, qu'est-ce que c'est que.*

Que dites-vous? What do you say?

Qu'est-ce? What is it?

Que deviendrons-nous? What will become of us?

Qu'est-ce qu'il dit? What does he say?

Je vous demande ce qu'il dit, I ask you what he says.

Qu'est-ce que la grammaire? What is grammar?

Qu'est-ce que c'est que ça? What is that?

4. *Quoi.*

Avec quoi avez-vous ouvert ce tiroir? With what have you opened this drawer?

Il y a quelque chose dans ce tiroir. Quoi? There is something in that drawer. What?

J'ai mis quelque chose dans ce tiroir. Quoi? I have put something in that drawer. What?

Quoi de plus honteux que le mensonge? What more shameful than lying?

Quoi faire? What is to be done?

EXERCISE XX.

VOCABULARY

abricot (m.) apricot
abricotier (m.) apricot-tree
aliment (m.) food (food-stuff), kind of food
asperge (f.) asparagus
avoine (f. s.) oats (pl.)
la bécasse, woodcock
la bécassine, snipe
la betterave, beetroot
le blé, corn
la boucherie, butcher's shop, meat market
le boulanger, baker
le brochet, pike
le brugnon, nectarine
le canard, duck
la carpe, carp
la carotte, carrot
le cerf, stag
la cerise, cherry
le cerisier, cherry-tree
la chair, flesh
le chasseur, sportsman, hunter
le chevreuil, roebuck
le chou, cabbage
le cidre, cider
le coq de bruyère, grouse
le dindon, turkey
eau douce, fresh water
éperlan (m.), smelt
espèce (f.), kind
étang (m.), pond
le faisan, pheasant
la farine, flour
la faux, scythe
la fève, bean
le filet, net
le fruit, fruit
le fusil, gun (fowling-piece)
le gibier, game
le hareng, herring
le haricot, haricot-beans
le lac, lake
le légume, vegetable
le levain, yeast
le lièvre, hare
la ligne, line
la machine, machine, machinery
le maquereau, mackerel
la mer, sea
le merlan, whiting
le meunier, miller
le moissoneur, reaper
la morue, cod
le moulin, mill
le mouton, sheep
la nourriture, food (sustenance)
oie (f.), goose
oiseau (m.), bird
orge (f.), barley
le pain, bread
la pâte, dough
le paysan, peasant
la pêche, peach
le pêcher, peach-tree
le pêcheur, fisher, fisherman
la perche, perch
la perdrix, partridge
la plante, plant
la poire, pear
le poirier, pear-tree
le pois, pea
le poisson, fish
le poisson de mer, salt-water fish
la pomme de terre, potato
le pommier, pear-tree
le potager, vegetable garden, kitchen garden
la poule, fowl
la prune, plum
le prunier, plum-tree
la raie, skate
le raisin, grape
le ruisseau, brook
le sanglier, wild boar
le saumon, salmon
le seigle, rye
la sole, sole
le terrain, plot of ground
la truite, trout
le turbot, turbot
le veau, calf
le verger, orchard
la viande, meat
la viande de boucherie, butcher's-meat
la vigne, vine
le vin, wine
la volaille, poultry

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connu, known
délayé, mixed
différent, different
frais, new (of bread)
fruitier, fruit (fruit-bearing)
principal, principal
rassis, stale

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avec, with
oui, yes
pour, for, in order to, to

ajouter, to add
attraper, to catch
changer, to change
cultiver, to cultivate
faucher, to mow
faire, to make
manger, to eat
nommer, to call
tuer, to kill

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il fait, he makes
il produit, it produces
ils servent, they serve
ils croissent, they grow

Translate into French

[In the following exercise passive forms are to be rendered by *on* and an active verb: "the animals of which the flesh is eaten," *les animaux dont on mange la chair.*]

What are the principal kinds of food which serve for (*à*) the sustenance of man? They are bread, meat, poultry, game, fish and vegetables. What is the plant which is cultivated to make bread (of it)? It is corn. Who cultivates corn? Peasants cultivate it. What are the principal kinds of corn? They are wheat, oats, barley, and rye. Who are those who mow the corn? The reapers. With what? With scythes. Into (*en*) what is corn changed to make bread (of it)? Into flour. Who is it that changes corn into flour? It is the miller. What is a mill? It is the machinery with which the miller changes corn into flour. What is dough? It is flour mixed with water. What is added to dough? Yeast is added to it. Who makes bread? It is the baker who makes bread. What is stale bread? Bread which is not new. What are the animals of which the flesh is eaten? They are the ox, the calf, the sheep. What is butcher's-meat? It is the flesh of domestic animals. What is game? We call game the animals which are not domestic animals and of which the flesh is eaten. What are they? The stag, the roebuck, the wild boar, the hare. Who are they who kill those animals? They are sportsmen. With what do they kill them? With guns. Is the flesh of birds eaten? Yes, there are some birds of which the flesh is eaten. Which? Fowls, turkeys, ducks, and geese. Are there any other birds of which the flesh is good to eat? Yes, there are other birds of which the flesh is good to eat; they are wild birds, such as the partridge, the woodcock, the snipe, the pheasant and grouse. What are the different kinds of fish? There are salt-water fish and fresh-water fish. What is fresh water? The water of lakes, ponds, rivers and streams. What are the best-known sea-fish? They are (the) cod, herring, smelt, mackerel, sole, turbot, whiting and skate. And the fresh-water (those of fresh-water)? Salmon, trout, carp, perch, and pike. Who are those who catch fish? They are fishers. With what? With lines and nets. What is eaten with meat? Vegetables. What are vegetables? They are plants that also serve for the sustenance of man. What are the principal vegetables that are cultivated in France? Potatoes, cabbages, beetroot, carrots, asparagus, beans, haricot-beans, and peas. What is a kitchen garden? It is the garden or plot of ground where vegetables are cultivated. And an orchard, what is that? It is the plot of ground in which there are fruit-trees. What are the principal fruit-trees and their fruit? The pear-tree, of which the fruit is the pear; the cherry-tree, which produces cherries; the peach-tree, on which peaches grow; the nectarine, of which the fruit has the same name as the tree; the plum-tree and the apricot-tree, which give us plums and apricots; and the apple-tree, with the fruit of which cider is made. What is the plant which is cultivated to make wine (of it)? It is the vine. What is the fruit of the vine? It is the grape.

Key to Exercise XIX.

Vous me demandez l'histoire de mon bouvreuil; la voici. Un de mes amis a une maison à la campagne. Je passe quelquefois l'hiver chez lui. Moi, j'aime la campagne en hiver; vous aimez mieux la ville, vous. Chacun son goût. Il y a deux ans j'y ai fait un séjour de plusieurs mois, et pendant que j'y étais j'ai fait la connaissance d'un bouvreuil. Il était un peu plus gros qu'un moineau. Il avait le bec épais, noir et dur. Ses petits yeux avaient une expression aimable. Je n'ai jamais vu de plumage plus beau, plus lustré que le sien. Il avait la tête noire et la poitrine presque aussi rouge que celle d'un rouge-gorge. Il avait les ailes tachetées de rouge aussi. Il avait la voix douce et je n'ai jamais entendu de sons plus moelleux et plus variés que ceux qu'il filait. Il m'égayait et me charmait. Je le soignais, je le caressais. Quand on m'apportait mon déjeuner je lui donnais le sien aussi. Je lui donnais tout ce qu'il aimait le plus: des miettes de pain, de petits morceaux de biscuit et de sucre. Il les becquetait dans ma main. Nous étions (de) bons amis, lui et moi. L'hiver était rude, mais cela ne nous inquiétait pas. Un bon feu flambait dans la cheminée. Nous avions une ample provision, moi de livres, lui de chenevis. Nous étions heureux l'un et l'autre. Nous étions contents l'un de l'autre. Pour les oiseaux une cage n'est souvent qu'une prison. La sienne n'était qu'une chambre à coucher. La porte en était toujours ouverte. Presque toute la journée il vagabondait à travers la chambre. Elle n'était pas plus à moi qu'à lui. Quelquefois il voletait autour de moi. Il sautait sur mon épaule et même sur ma tête (Il me sautait sur l'épaule et même sur la tête). Il m'ébouriffait les cheveux. Cela l'amusait et moi aussi. C'était un gai compagnon. Je n'en ai jamais eu de plus gentil que celui-là. Je ne passais pas toutes mes soirées avec lui. Quand je rentrais je le trouvais endormi. Le bruit de mes pas l'éveillait. Il me saluait par un petit gazouillement. Le lendemain, moi, j'étais éveillé par mon petit ami. Mais la fin de mon histoire est quelque chose de bien triste. Un jour le bouvreuil trouve la croisée entre-baillée. Pendant que j'ai le dos tourné il passe vite dehors. A vingt pas de la maison il y a un gros fumier jaune et noir où une demi-douzaine de poules grattent et becquètent. Ce n'est rien de beau, mais c'est quelque chose d'intéressant pour lui. Du rebord de la fenêtre il vole sur le fumier. Mais c'est un intrus. Les poules ont l'humeur intolérante et hargneuse. La vue du bouvreuil les fâche. Elles l'entourent, le houspillent, l'attaquent. Le bruit m'attire. Je regarde par la croisée. C'est lui; c'est mon pauvre bouvreuil. J'enjambe la fenêtre; je vais au secours de mon petit compagnon. Je chasse les poules. Je le tire de leurs griffes. Il est trop tard. Mon pauvre petit compagnon est mort.

Continued

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XLII. Strong Verbs. The following strong verbs change the stem-vowel -ei- into -i- or -ie- in the imperfect and past participle. Those verbs which are made prominent in print are conjugated with **ſein**, all others with **haben**.

Infinitive		Present Tense I., II., III. Singular	Imperfect *Indicative*	Imperfect *Conjunctive*	Imperative	Past Participle
befleiʹßen	to bestow pains upon a thing, to apply one's self to	ich befleiß-e, -eſt, -t	ich befliß	ich befliſſe	befleiß(e)	befliſſen
beißen	to bite	ich beiß-e, -eſt, -t	ich biß	ich biſſe	beiß	gebiſſen
bleiben	to remain	ich bleib-e, -ſt, -t	ich blieb	ich bliebe	bleib(e)	geblieben
erbleiʹchen*	to die, to turn pale	ich erbleich-e, -ſt, -t	ich erblichʹ	ich erbliche	erbleich(e)	erblichen
gedeiʹhen	to thrive	ich gedeih-e, -ſt, -t	ich gedieh	ich gediehe	gedeih(e)	gediehen
gleichen	to equal	ich gleich-e, -ſt, -t	ich glich	ich gliche	gleich(e)	geglichen
gleiten	to slide, glide	ich gleit-e, -eſt, -et	ich glitt	ich glitte	gleit(e)	geglitten
greifen, ergreifen	to seize, catch, lay hold on	ich greif-e, -ſt, -t	ich griff	ich griffe	greif(e)	gegriffen
kneifen	to pinch	ich kneif-e, -ſt, -t	ich kniff	ich kniffe	kneif(e)	gekniffen
leiden	to suffer	ich leid-e, -eſt, -et	ich litt	ich litte	leide	gelitten
leihen	to lend	ich leih-e, -ſt, -t	ich lieh	ich liehe	leih(e)	geliehen
meiden	to shun	ich meid-e, -eſt, -et	ich mied	ich miede	meide	gemieden
pfeifen	to whistle	ich pfeif-e, -ſt, -t	ich pfiff	ich pfiffe	pfeif(e)	gepfiffen
preiſen	to praise	ich preiſ-e, -eſt, -t	ich pries	ich prieſe	preis(e)	geprieſen
reiben	to rub	ich reib-e, -ſt, -t	ich rieb	ich riebe	reib(e)	gerieben
reißen	to tear	ich reiß-e, -eſt, -t	ich riß	ich riſſe	reiß(e)	geriſſen
reiten†	to ride	ich reit-e, -eſt, -et	ich ritt	ich ritte	reit(e)	geritten
ſcheiden	to depart	ich ſcheid-e, -eſt, -et	ich ſchied	ich ſchiede	ſcheide	geſchieden
ſcheinen	to shine, seem	ich ſchein-e, -ſt, -t	ich ſchien	ich ſchiene	ſchein(e)	geſchienen
ſchleichen	to sneak, crawl	ich ſchleich-e, -ſt, -t	ich ſchlich	ich ſchliche	ſchleich(e)	geſchlichen
ſchleifen‡	to sharpen, grind	ich ſchleif-e, -ſt, -t	ich ſchliff	ich ſchliffe	ſchleif(e)	geſchliffen
ſchneiden	to cut	ich ſchneid-e, -eſt, -et	ich ſchnitt	ich ſchnitte	ſchneid(e)	geſchnitten
ſchreiben	to write	ich ſchreib-e, -ſt, -t	ich ſchrieb	ich ſchriebe	ſchreib(e)	geſchrieben
ſchreien	to shout	ich ſchrei-e, -ſt, -t	ich ſchrie	ich ſchriee	ſchrei(e)	geſchrieen
ſchreiten	to stride	ich ſchreit-e, -eſt, -et	ich ſchritt	ich ſchritte	ſchreit(e)	geſchritten
ſchweigen	to keep silence	ich ſchweig-e, -ſt, -t	ich ſchwieg	ich ſchwiege	ſchweig(e)	geſchwiegen
ſpeien	to spit, vomit	ich ſpei-e, -ſt, -t	ich ſpie	ich ſpiee	ſpei(e)	geſpieen
ſteigen	to rise, mount, ascend	ich ſteig-e, -ſt, -t	ich ſtieg	ich ſtiege	ſteig(e)	geſtiegen
ſtreichen	to stroke	ich ſtreich-e, -ſt, -t	ich ſtrich	ich ſtriche	ſtreich(e)	geſtrichen
ſtreiten	to quarrel	ich ſtreit-e, -eſt, et	ich ſtritt	ich ſtritte	ſtreit(e)	geſtritten
treiben	to drive, press	ich treib-e, -ſt, -t	ich trieb	ich triebe	treib(e)	getrieben
verbleiʹchen	to fade, to decease	ich verbleich-e, -ſt, -t	ich verblich	ich verbliche	verbleich(e)	verblichen
verzeiʹhen	to forgive	ich verzeih-e, -ſt, -t	ich verzieh	ich verziehe	verzeih(e)	verziehen
weichen §	to yield, give way	ich weich-e, -ſt, -t	ich wich	ich wiche	weich(e)	gewichen
weiſen	to show, point out	ich weiſ-e, -eſt, -t	ich wies	ich wieſe	weiſe	gewieſen
zeihen	to accuse	ich zeih-e, -ſt, -t	ich zieh	ich ziehe	zeih(e)	geziehen

* To die: strong; to turn pale: weak—examples: er erblichʹ and er erbleichʹte; as transitive bleichen (to bleach) takes weak inflections: er hat die Leinwand gebleicht, he has bleached the linen.

† Reiten is conjugated with ſein and haben; the rules of the alternative conjugations will follow later.

‡ Schleifen in the sense of to trail, to pull along, and to demolish, is weak: der Wagen, die Feſtung wurde geſchleift, the carriage was pulled along, the fortress was pulled down; but: das Meſſer wurde geſchliffen, the knife was sharpened. Schleifen in the sense of "to skate," or "to dance" also takes weak inflections.

§ Erweiʹchen, to soften, mollify, touch, is weak.

XLIII. Plural of Compound Nouns. As a rule the last word only of compound nouns takes the plural: der Nacht=Schmetterling (*sing.*) the night-butterfly, die Nacht=Schmetterlinge (*pl.*); das Bauernweib (*sing.*) the peasant-woman, die Bauernweiber (*pl.*). Several compound nouns contain already in the singular words used in the plural: die T ö c h t e r schule (*sing,*), the school for girls [daughters]; der B ü c h e r wurm, the bookworm; der B i l d e r saal, the picture-gallery. The plural of these is formed in the usual way, by changing the number of the last word; die Töchterschulen, etc.

1. Several compounds with -Mann (man) form an irregular plural with -Leute (folk, people): der Hauptmann (*sing.*) the captain, die Hauptleute (*pl.*); der Kaufmann (*sing,*) the merchant, die Kaufleute (*pl.*); der Seemann, the sailor, die See=leute (also die Seemänner), etc. Others form the regular plural with -Männer—examples: der Staatsmann, the statesman, die Staats m ä n n e r; der Gewährsmann, the warranter, surety, guarantee, die Gewährs m ä n n e r; der Ehrenmann, the man of honour, die Ehren m ä n n e r, etc.

2. The application of the plural - l e u t e or - m ä n n e r confers a different meaning to several words belonging to this class: Dienst m ä n n e r (*pl.*) messengers, and Dienst l e u t e (*pl.*) servants; Ehe m ä n n e r (*pl.*) husbands, and Ehe l e u t e, husband and wife. The substantive der Bauer, the peasant, forms the regular plural die Bauern, and also the compound plural die Bauersleute, denoting peasants of both sexes.

XLIV. Plural of Nouns of Measure. Substantives of measure, when used after cardinal numbers and in a collective sense, generally retain the form of the singular in the plural: fünfzig Pfund (*sing.*) schwer, fifty pounds [heavy] of weight; zwanzig Stück (*sing.*) Tuch, twenty pieces of cloth; 16 Faust (*sing.*) hoch, 16 ["fists"] hands high; 4 Sack (*sing.*) Kaffee, 4 bags of coffee; 100 Mann (*sing.*) Garde, 100 men of the Guards; fünf Dutzend (*sing.*) Federn, five dozen pens, etc.

1. The nouns of measure of *feminine* gender, ending in an unstressed -e, always form the plural by adding an -n: fünf Flasche-n (*pl.*) Wein, five bottles of wine; zehn Meile-n (*pl.*) weit, ten miles distant; acht Kiste-n Indigo, eight boxes of indigo; 50 Tonne-n (*pl.*) Eisen, 50 tons of iron; die Million (*sing.*) forms the plural die Million-en.

2. Nouns indicating the measure of time always form their plural with an inflection: das Kind ist sechs Jahr-e, drei Monat-e und vier Tag-e alt, the child is six years, three months and four days old.

XLV. Conjunctions. These serve either to co-ordinate or to subordinate clauses or words. In *co-ordination* the joined sentences retain their full independence and their original weight, the structure of the sentences joined by the conjunction remaining unaltered. Conjunctions of this class are:

und, and	dessen un'geachtet, nevertheless
sowohl' . . . . . als, as well . . . . . as	den'noch, yet
aber, but	einerseits . . . anderseits, on the one hand, on the other hand
allein', but, only	darum, deshalb, therefore
o'der, or	nämlich, namely
son'dern, but	

Examples: Die Sonne scheint, die Blumen blühen u n d die Vögel singen, the sun shines, the flowers bloom, and the birds sing, etc.

The *subordinative* conjunctions connect two sentences, one of which is subordinated to the other. The subordinate clause is not complete in itself, and has no sense if detached from the sentence on which it depends Conjunctions of this class are:

daß that	ob, whether
so daß, so that	wenngleich, obgleich, although
ohne daß, without	gleichwie, as
auf daß, damit, so that	nachdem, after
als, da, wie, as, than	bis, till, until
inwiefern, insofern, in so far as	ehe, bevor, before
während, whilst	weil, because
seit, since	wenn, if, when
je nachdem, according to	falls, in case
als ob, as if, as though	etc.

1. The border-line which separates conjunctions, adverbs, and prepositions is not very distinct; adverbs are often used as conjunctions, and conjunctions as prepositions—for instance: während signifies "whilst" and "during." Example: Wir wanderten während der Nacht, we wandered during the night; and der Tag war schön, während die Nacht regnerisch war, the day was fine, whilst the night was rainy.

2. The following interrogative pronouns are classed among the conjunctions if they are used to connect relative or subordinate clauses:

wo, where	wobei, whereat, at which
womit, wherewith	woher, whence
worin, in which, wherein	weshalb, wherefore
wie, how	wohin, where to, whither
worauf, whereupon, upon which	wann, when
	warum, why
	weswegen, wherefore

Examples: Dies war es, worin ich bei'stimmte. It was that, to which [whereto] I assented; ich verstand nicht, worauf er an'spielte, I did not understand to what he alluded.

3. If the conjunction introduces the subordinate clause the verb must be placed at the end; in compound tenses the auxiliary verb occupies the last place: Er sah mich, e h e ich ihn s a h, he saw me before I saw him; and er sah mich, e h e ich ihn gesehen h a t t e, he saw me before I had seen him; er schlief, a l s wir k a m e n, he slept when we came; and er schlief, a l s wir gekommen w a r e n, he slept when we had come.

4. If the subordinate clause with the conjunction is placed at the beginning of the complex sentence, the verb in the second sentence must *precede* the subject: E h e er mich sah, ging (verb) ich (subject) fort, before he saw me, I went away; a l s sie ab'reiste, w a r (verb) es (subject) schon

dunkel, when she departed, it was already dark. If the same sentences are reversed, subject and verb resume their normal position in the principal sentence: Ich ging fort, ehe er mich sah; es war schon dunkel, als sie abreiste.

EXAMINATION PAPER XII.

1. Which vowels are taken in the imperfect and in the past participle by strong verbs with the stem-vowel -ei-?
2. Under what circumstances do certain verbs in this group form a weak imperfect and past participle, and which are these verbs?
3. Which word of a compound substantive takes the plural, and which remains unchanged?
4. In what circumstances do both words show the plural form?
5. How is the plural of compounds with -mann formed?
6. Which nouns denoting measure do not take the plural, and which form the plural with the usual inflections?
7. Which nouns of measure always take the inflectional -n in the plural?
8. How is the position of the verb influenced by a subordinative conjunction, introducing a subordinate clause?
9. How is the auxiliary verb in compound tenses placed in a subordinate clause introduced by the subordinative conjunction?
10. What rule has to be observed with regard to the position of subject and verb in clauses where the subordinative conjunction is placed at the beginning of the compound sentence?

EXERCISE 1. (*a*) Change the present tense of the verbs in the following sentences into the *imperfect* and *perfect:*

Ich bleibe zu Hause; du pfeifst laut; das Mädchen
I stay at home; you whistle loudly; the girl
reibt die Diele; wir schreiben Briefe; das Kind
scrubs the floor: we write letters; the child
schreit entsetz'lich; die Männer schweigen;
is screaming terribly; the men keep silence;
wir steigen auf den Berg; ich verzeihe Ihnen;
we ascend the mountain; I forgive you;
der Hirt treibt das Vieh auf die Weide;
the shepherd turns the cattle out to graze;
der Knabe weist mir den Weg ins Dorf.
the boy shows me the way to the village.

(*b*) Change the imperfect and perfect of the following sentences into the present tense:

Ich biß in den Apfel; weshalb bist du nicht
I bit into the apple; why did you not
bei uns geblieben? Der Künstler ergriff das Instrument';
stay with us? The artist seized the instrument;
wir haben große Schmerzen gelitten; der Kutscher
we have suffered great pain(s); the coachman
pfiff eine Melodie; das Mädchen hat eine Rose
whistled a tune; the girl has pulled a rose
vom Zweige gerissen; die Sonne schien hell;
off the branch: the sun was shining brightly;
der Bettler schlich an der Mauer hin; was haben Sie
the beggar crept along the wall; what have you
mir geschrieben? Der Mann und die Frau
written to me? The man and the woman
stritten heftig.
quarrelled violently.

EXERCISE 2. (*a*) Change the singular of the compound nouns and words agreeing with them in the following sentences into the plural. [The compounds are indicated by the sign =.]

Wo ist mein Tinten=faß (*n.*)? Ich kann nicht
Where is my inkstand? I cannot
meinen Hand=schuh (*m.*) finden. Geben Sie mir mein
find my glove. Give me my
Taschen=tuch (*n.*). Die Messer=klinge (*f.*) ist gebrochen;
handkerchief. The blade of the knife is broken;
die Pfauen=feder (*f.*) ist schön; das Arm=band (*n.*)
the peacock-feather is beautiful; the bracelet
war aus Gold; der Fuß=boden (*n.*) war
was of gold; the floor was
mit Teppichen belegt; das Wein=glas (*n.*) ist leer;
covered with carpets; the wine-glass is empty;
der Gold=schmied (*m.*) hat schöne Ringe.
the goldsmith has beautiful rings.
Aus welchem Stoffe ist Ihre Hals=binde (*f.*)?
Of what material is your necktie?
Geben Sie mir gefälligst das Obst=messer (*n.*).
Pass the fruit-knife, if you please.

(*b*) Change the plural of the compounds and words in agreement with them into the singular:

Die Sing=vögel (*m.*) ziehen im Herbst nach dem
The singing-birds migrate in the autumn to the
Süden; die seidenen Regen=schirme (*m.*) sind nicht sehr
south; the silken umbrellas are not very
haltbar; die Augen=lider (*n.*) sind geschwollen; ich kaufte
durable; the eyelids are swollen; I bought
einige Erd=beeren (*f.*). Wohin führen diese Wald=
some strawberries. Whither lead these forest-
pfade (*m.*)? Ich besitze zwei Winter=röcke (*m.*).
paths? I possess two [winter] overcoats.

(*c*) Form the plural of the compound nouns and words agreeing with them in the following sentences. [Remember the rules concerning the plural of nouns with the indefinite article.]

Der Hauptmann (*m.*) kommandirte die Truppen;
The captain commanded the troops;
ich sandte den Dienstmann nach Hause; ein Kaufmann
I sent the messenger home; a merchant
muß rechnen können; ein Staatsmann sollte
must know how to calculate: a statesman ought
nicht irren; ein junger Ehemann
not to [err] make mistakes; a young husband
ist gewöhnlich nachgiebig.
is generally indulgent.

(*d*) Form the plural of the following nouns of measure, changing the cardinal numeral one into ten:

Ein Pfund Kaffee, ein Bund Stroh,
One pound of coffee, one bundle of straw,
ein Faß Petroleum, ein Buch Papier,
one barrel of petroleum, one quire of paper,
ein Sack Reis, eine Flasche Wein,
one bag of rice, one bottle of wine,
ein Ballen Wolle, eine Tonne Kohle,
one bale of wool, one ton of coal.
eine Woche, eine Stunde, eine Meile,
one week, one hour, one mile,
ein Kubik=Fuß Holz, eine Kiste Zucker.
one cubic foot of timber, one case of sugar

Exercise 3. Reverse the following subordinate clauses by putting the second clause in the first place (for instance: Er sah mich, ehe er fortging, he saw me before he went away; to be reversed: Ehe er fortging, sah er mich, before he went away, he saw me):

Wir rauchten, nachdem die Damen sich zurückgezogen hatten;
we smoked after the ladies had retired;
wir gingen fort, weil uns Niemand die Tür öffnete;
we went away because nobody opened the door for us;
er verschwand, ehe ich ihm ein Wort sagen konnte;
he disappeared before I could speak a word to him;
der Weizen wächst, wenn es genügend viel regnet;
the wheat grows if it rains sufficiently;
er frug mich, ob ich zürne; er wünschte
he asked whether I was angry; he wished
abzureisen, falls das Wetter es zuließe;
to depart in case the weather would allow it;
ich schlief, als er kam; sie sang ein Lied,
I slept when he came; she sang a song
da man sie bat, es zu tun; ich gehe nicht fort,
since she was requested to do so; I shall not go
solange Sie es mir nicht zugesagt haben.
until you have promised it to me (literally: I go not away as long as you have not promised it me).

Keys to Examination Paper XI.
(Pages 2490–2491)

Exercise 1. *Imperfect:* Ich nahm das Geld; der Knabe stahl einen Apfel; was geschah? ich las ein Buch; ihr saht nichts; gaben Sie nichts? du verbargst etwas; wir warfen den Ball; die Dame sprach englisch; ich aß Erdbeeren.

Pluperfect: Ich hatte das Geld genommen; der Knabe hatte einen Apfel gestohlen; was war geschehen? ich hatte ein Buch gelesen; ihr hattet nichts gesehen; hatten Sie nichts gegeben? du hattest etwas verborgen; wir hatten den Ball geworfen; die Dame hatte englisch gesprochen; ich hatte Erdbeeren gegessen.

Exercise 2. Das Lustspiel hat vier Akte; in seinen Träumen hatte er seltsame Gesichte; die Ritter erhoben ihre Schilde; der Richter brachte die Akten; alle hatten bleiche Gesichter; die Schilder über den Ladentüren waren gemalt; wie viele Bände haben Sie? Die Bänder des Hutes sind rot; die Bauer der Vögel waren aus Gold; die Bauern kennen das Wetter.

Exercise 3. Wer ist dieser Herr? Was meinen Sie? Wessen Hut ist das? Wem gehört dieses Buch? Wen sahen Sie gestern? Welchem Manne gehört das Boot? Welche Dame kennen Sie? Welche Kinder sollen eingeladen werden? Was für ein glänzender Spieler er ist! Welches schöne Kind sahen Sie? Welch' schönes Kind! Was für Leute sind sie? Was für Getränke bestellten Sie? Was für eine Frau war es?

Exercise 4. Diesseits der Mauer, innerhalb des Gartens, stand ein Mann inmitten der Wiese. Zufolge eines Berichtes (or: einem Berichte zufolge) war der Feind geflohen. Trotz meiner Warnungen sprach er mit ihm; um des Himmels willen! Meinem Hause gegenüber wohnt ein Schneider seit einem Jahre; ich öffnete mittelst eines Schlüssels die Türe. Seit Ihrer Abreise sah ich ihn nicht mehr; wir spazierten durch den Garten gegen den Wald; er tat es wider meinen Willen.

Continued

End of Third Volume